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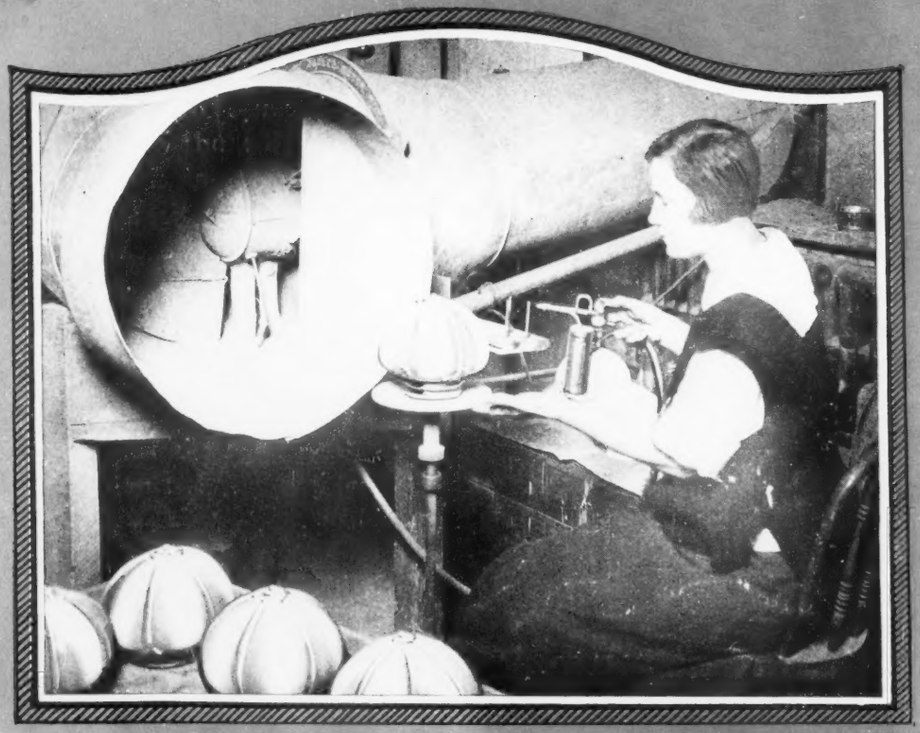

COMPRESSED AIR IS OFTEN USED IN GLASS PLANTS TO SPRAY THE DECORATIVE FINISH ON ELECTRIC-LIGHT SHADES

Graphite a Mineral of Rapidly Widening Uses
R. C. Rowe

Kaibab Trail in Grand Canyon Finished
M. R. Tillotson

Putting Power of Georgia's Rivers to Work
J. E. O'Rourke

Making a Suburban Ice Plant Successful
Chester J. Conn

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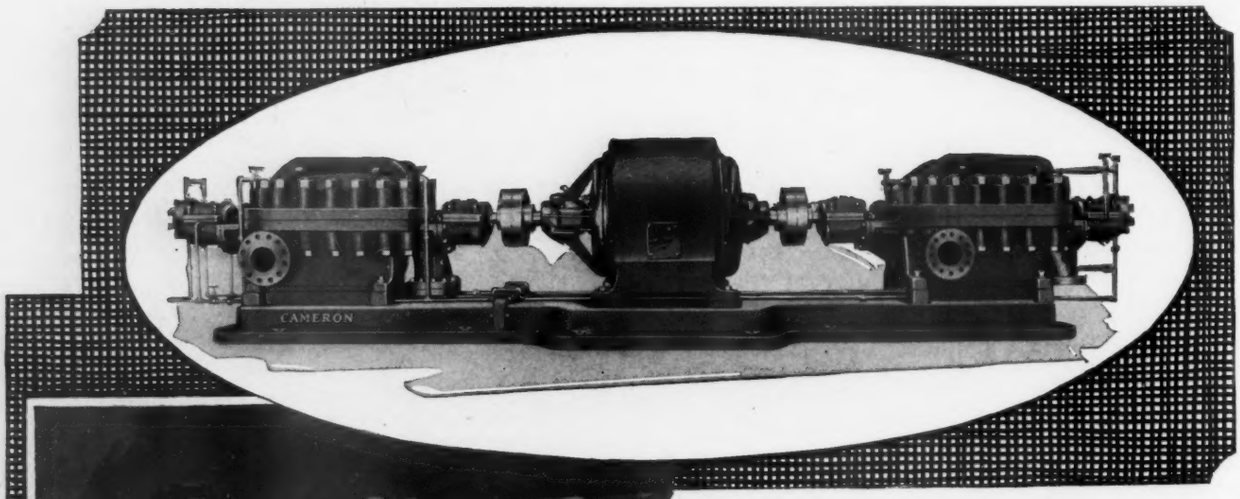

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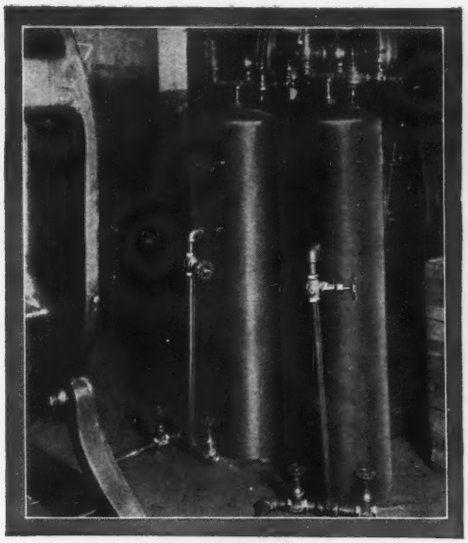

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At the West Portal, the predominating rocks were gneiss and schist which were badly decomposed from weathering. Here a great part of the drifting was done with "Jackhamer"-type drills and lightweight drifters.

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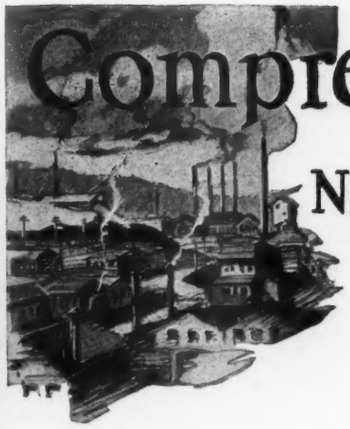

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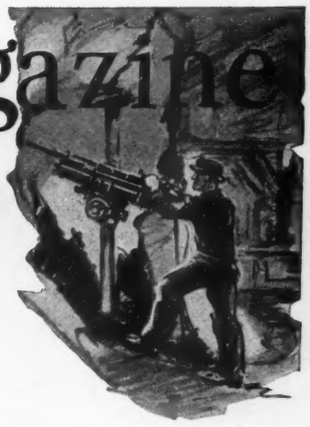

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Kaibab Trail in Grand Canyon Finished

Portable Compressors and Air-Driven Rock Drills Made Possible This Marvelous Scenic Route

By M. R. TILLOTSON*

THE building of trails in the Grand Canyon of the Colorado River is beset with many difficulties and numerous hazards; and a full measure of these was encountered in constructing the Kaibab Trail so that tourists might find it comparatively easy to reach points from which to view the marvels of the canyon to the best advantage.

In the accompanying article the author, who is intimately identified with the engineering problems involved in making and keeping that National Park accessible, has described in detail how nature opposed and how man overcame her obstacles in building the Kaibab Trail.

"THE Wonder Trail of the West." Such was the appellation given by a congressional delegation to a recently completed monument to the skill and daring of western trail builders and to the achievements made possible by the use of modern air-power equipment. This party of distinguished visitors was the first to travel, on June 23, 1925, the new trail—christened the "Kaibab"—by which the National Park Service has made more readily and safely accessible to its thousands of annual visitors the depths of that greatest of all world wonders, the Grand Canyon of the Colorado River.

Hundreds of ancient cliff dwellings, still to be seen in the Grand Canyon, give evidence of a prehistoric people that lived and had their being in those vast depths probably centuries before the Grand Canyon was discovered, in 1540, by Don Lopez de Cardenas, whose quest was made as a result of stories brought by Hopi Indians to Don Pedro de Tovar, of Coronado's expedition. There has been found no evidence of trails or paths that might have been used by this forgotten race. Perhaps they even avoided such faint trails as existed among the rocks and cliffs where lurked the savage animals that were their enemies. Possibly not until ancient man became acquainted with the use of the stone axe, the spear, or the bow as a means of defense did he dare to travel openly and in a well-defined course.

With the advance of a crude civilization, there came into more or less general use the less inaccessible routes afforded by occasional breaks in the many cliffs forming the walls of the canyon; and some of the old Supai Indians still living in that vicinity will tell you how, in their boyhood, they traveled the great geologic fault which is now the route of the famous Bright Angel Trail. Sturdy Mormon emigrants, sent out by Brigham Young and his followers to populate and to develop through irrigation the arid southwest, were responsible for the improvement of trans-canyon trails. Further improvements and additions were made by early-day prospectors and miners until, at the present time, there are a number of routes by which a courageous and hardy explorer might possibly reach the Colorado River from the canyon's rim. Among them are the Tanner, Hance, Grand View, and Bass trails. These are all well-nigh impassable, and none is to be recommended to the average tourist or "dude" unaccustomed to the dangers and the hardships of travel over canyon trails for long years unused and unrepaired.

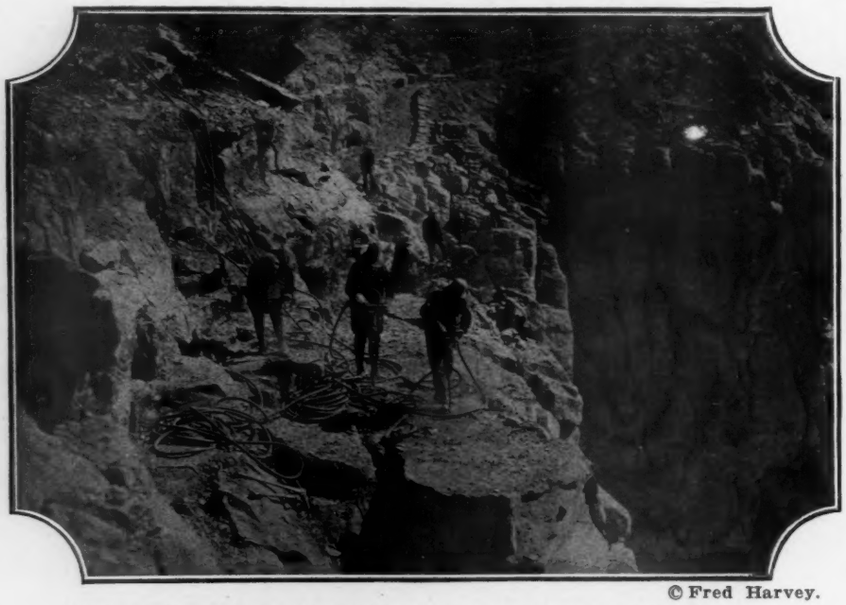
The first serious attempt towards the construction of a real trail into the Grand Canyon was made in 1881, when there was undertaken the task of blazing a way in from House Rock Valley by way of Nankoweap Creek, on the North Rim. This was done for the purpose of transporting men and supplies sent by the Federal Government to make the first geological surveys of the canyon under the direction of Maj. John Wesley Powell. It is an interesting fact that Mr. John F. Brown, construction foreman on the project which forms the subject of this article, was a prominent member of that trail-building crew of 45 years ago.

In 1912, the Santa Fe Railway Company built the Hermit Trail to one of Fred Harvey's resorts, known as Hermit Cabins, in the canyon. By this trail, which starts at a point 7¾ miles west of the El Tovar Hotel, Hermit Camp is reached after traveling a distance of 7½ miles and the Colorado River after going another 1½ miles. Following the creation of Grand Canyon National Park, in 1919, this trail was turned over to the Park Service, and it is now operated and maintained by the Government. Although the Hermit Trail is excellent from a construction point of view, it is so located that it is subject to many landslides and washes during the severe rainstorms that occur in the summer season when tourist travel is at a peak. Furthermore, many stretches of adverse grade make the distance seem unnecessarily long.

Undoubtedly, the most famous canyon trail is the Bright Angel. This route has been in continuous use for many years—even before the coming of the white man. By a rather tangled sequence of legal complications, title to the Bright Angel Trail has passed from one hand

*Park Engineer, Grand Canyon National Park.

to another until it is now vested in Coconino County and is operated as a toll trail. Thus the principal route of canyon travel entirely within the Crand Canyon National Park, operated for the people by the Federal Government, became a trail that the people are allowed to use only upon payment of $1 toll to the local county government. Furthermore, the Park Service can exercise no control over the maintenance of Bright Angel Trail; and its upkeep and all necessary improvements are handled by the county if and as funds permit.



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"Jackhamers" drilling blast holes in the Coconino sandstone formation.

Located at the bottom of the great Bright Angel Fault, which extends entirely across the canyon from its north to its south rim, Bright Angel Trail lies for the most part where the winter sun never shines. Snow and ice on its steep grades add a very serious element of danger during all the winter months. Although the tread is of ample width, an exceedingly steep gradient—which reaches a maximum of 37 per cent.—makes travel over Bright Angel Trail difficult in the extreme for both pedestrians and animals.

Recognizing the fact that this most widely used of main trails leading into the canyon should be rebuilt as far as possible on easier grades and put under Government control both for the sake of assuring adequate maintenance and of avoiding the toll feature, there was held a joint meeting of county officials and of officers of the governmental branches concerned looking towards a solution of the problem. The agreement reached was, in effect, that the Government should purchase the trail from the county for the sum of $100,000; that the money so received should be used by the county for the construction of a modern auto road from the main transcontinental highway, some 64 miles distant, to the Grand Canyon; that this road should be built under Government supervision; and that the Federal authorities should contribute a sum equal to that put up by the county, at the same time pledging an additional $100,000 annually until the completion of the road—the estimated cost of the project being anywhere from $500,000 to $800,000.

As soon as Federal-enabling legislation was enacted, the County Board of Supervisors advertised the trail for sale in accordance with the agreement and with the state laws governing the sale of county property. However, there developed much local opposition to the scheme; and by referendum petition the matter was placed on the ballot, whereby the sale was defeated by a large majority.

The bill carrying the funds for the proposed purchase very wisely provided that if, for any reason, the county should fail to consummate the sale, the funds appropriated might be used "for the construction of trails in Grand Canyon National Park." In the meantime, Park Service officials and engineers had for several years past been making a thorough study of the entire situation with a view to selecting the most feasible route for a trail into the canyon. As a result, a route has been chosen which starts at Yaki Point, some 3½ miles east of the El Tovar Hotel, and generally follows a long ridge extending into the canyon from the South Rim.

Preliminary reconnaissance surveys and careful studies of this route during all seasons of the year indicated that it possessed the following advantages: except for the first 1,465 feet, the trail is located where it will be reached by the sun and will therefore be fairly free from snow during the winter; by following near the top of the ridge, drainage will be easy to handle and danger from serious landslides will be reduced to a minimum; by keeping the route out of a fault or side canyon, such as that in which the Bright Angel Trail is located, the tourist will have an unobstructed view of the entire canyon and, at the same time, will be in reach of the prevailing summer breeze which has as much to do as shade in making summer travel comfortable; a comparatively easy gradient can be maintained; the travel distance, particularly to the Phantom Ranch—a Fred Harvey resort at the bottom of the Canyon—and to the North Rim, is materially reduced; and, last but not least, along this route were found the most favorable breaks in the many sheer cliffs of the canyon walls.

Immediately following the November election, with preliminary plans and surveys already concluded, arrangements were made for the purchase of needful supplies and equipment, the establishment of camps, the building of necessary construction roads, and the organization of crews, etc., with the result that actual construction work was started on December 2, 1924.

The excellent results already obtained through the use of an Ingersoll-Rand 4¼x4-inch portable air compressor, operated under the direction of an engineer in charge of a similar job described in the April, 1925, issue of this magazine, were sufficient recommendation to justify the purchase of two similar machines for this project. Evidence of the dependence placed upon air-power equipment by the Park Service officials at Grand Canyon is strikingly brought out by the fact that the first action taken upon authorization

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The portable compressor at work on a difficult part of the job.

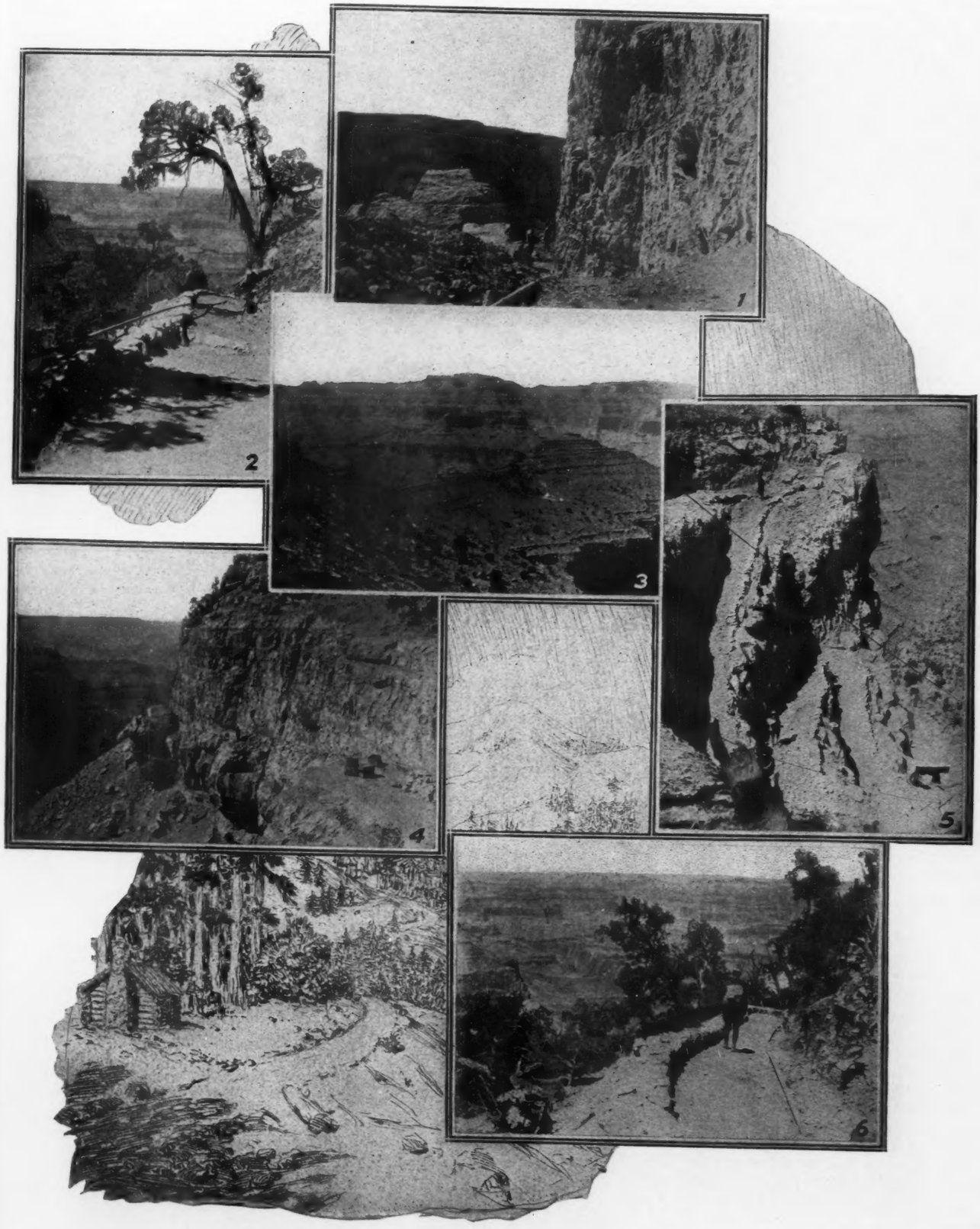

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Fig. 1—Where the sheer face of a limestone cliff was cut away to form a trail section having a 17 per cent. gradient.
Fig. 2—A stretch of finished trail with line of pipe still in place through which air was sent from the compressor to the rock drills.
Fig. 3—Here, near the lower end, the trail follows the top of the ridge in the middle distance.
Fig. 4—Another view of the limestone cliff showing how the trail was made by drilling and blasting away the sheer rock face.
Fig. 5—Completed switchbacks that were built in the Kaibab limestone formation.
Fig. 6—Section of completed trail having an inward slope and finished with a marginal rock wall.

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Section of completed trail near the lower end of the route.

of construction work was the purchase of the two compressors with the necessary accessories in the way of "Jackhamers," air hose, and drill steel.

Two construction camps were established, one on the rim to work toward the river and one at the bottom of the canyon to work upward toward the top. The lower camp, with a crew of 15 sturdy and dependable, hard-working Mormons from the Utah side of the Canyon, was in charge of foreman John F. Brown, while the upper camp was under the direction of Mr. Chick Seavey whose crew averaged around 20 men. The good-natured rivalry which existed between the "Mormon" and the "Gentile" crews was a material factor in keeping enthusiasm among the men at a high pitch, even in the face of the many hardships and dangers encountered in the course of continuous work during the heavy storms of an unusually severe winter.

Some idea of the transportation difficulties involved may be had when it is realized that the lower crew could be reached only by pack train. Every ounce of equipment—including tentage, camp furniture and utensils, blacksmith outfit, air compressor and accessories, all food supplies, a goodly share of the 11 tons of T.N.T used on the job, gasoline and oil for the compressor, etc.—had to be packed by mule back over extremely rough and precipitous canyon trails a distance of from 9 to 11 miles. The barren, rocky slopes on which the camp was located afforded not even fuel for cooking and heating, and all this also had to be packed in by mule back. As the nearest water was 3 miles from the first and 5 from the second camp site, all water for camp purposes, as well as that used in the radiator of the air compressor, necessarily had to be packed to the job. This required the continuous services of one man and two burros. For obvious reasons, the camp water carrier was promptly christened "Gunga Din," while his two long-eared assistants were named, respectively, "Christmas" and "Maxwellton." Upon inquiry it developed that these names were applied to one because it took him so long to come and to the other for the very good reason that her "brays were bonnie."

No difficulty was experienced in transporting the little 4¼x4-inch air compressor to the lower camp, as it is so simply and sturdily built that it can be completely knocked down, loaded on pack animals, taken any place that a train of pack mules can go, and be rapidly reassembled upon reaching its destination. It was easily moved by hand up the completed trail as work progressed until it reached the point where the two crews met. Thence two mules, hitched tandem, brought it back to the rim, where another job was already waiting for it.

Although there was little if any difference in the volume of work accomplished by the two crews, still the condition of the rock and cliffs was such that the upper crew could not progress as rapidly, in the way of linear footage, as the lower crew. It was therefore decided to pipe air to the drills of the upper crew from a point above, especially as by so doing it was possible to use an Ingersoll-Rand 6x6-inch Type Fourteen compressor that had already seen service on various park construction jobs for a number of years. This machine, while portable in the ordinary meaning of the word, is not capable of being transported over mountain trails as is its smaller 4¼x4-inch brother. The two compressors were therefore hooked up so that both delivered to the same 2-inch pipe line which extended for a maximum distance of approximately 6,000 feet. The combined delivery of the two machines throughout this distance served to operate effectively one BCR and two BAR "Jackhamers," or four of the lighter outfits, alone.

Leaving the rim, the new trail strikes immediately into the rock formation known as Kaibab limestone. By a series of switchbacks cut right into the face of this solid rock ledge, some 260 feet in height, the route is carried to the talus slope at the bottom of the ledge. Thence it follows along this talus on a 15 per cent. grade for a distance of approximately half a mile to another limestone ledge that is absolutely vertical and some 50 feet thick. This ledge was negotiated by striking directly down its side on a 17 per cent. grade, with the result that the face of the cliff was drilled and blasted away leaving on the inside of the trail a perpendicular rock cliff exactly like the original wall but some 7 feet farther back in the ledge. The next serious obstacle encountered was the white wall or Coconino sandstone formation. This formation, though comparatively soft, was difficult to drill, and was cross-bedded to such an extent that even after shooting back the face of the cliff for a distance of 40 feet throughout its entire height there was not obtained a satisfactorily solid roadbed. Consequently, to get over the most troublesome portion of this ledge, there was used a solid rock-

© Fred Harvey.

Rock retaining wall at the foot of a cliff.

© Fred Harvey.

Close-up of a sharp turn or switchback.

fill held in place by a heavy rock retaining wall some 25 feet in height.

Through a solid, vertical cliff of red sandstone, 60 feet high, the trail was carried on an 18 per cent. grade by drilling and blasting away literally thousands of tons of rock. Below this, after cutting through several smaller ledges, the route reached a mesa relatively so level that for a distance of 2,430 feet it was impossible to make grade at a rate greater than 4 per cent. At the lower end of this mesa was encountered the most formidable of all rock formations in the canyon, that known as "blue lime." This wall—which belies its name in that its face is stained a rusty red from the Supai drift formation directly above—extends almost without a break for the full length of the Grand Canyon proper; has an average thickness of 200 feet; and is unbelievably hard. Without a single exception, every trail route ever constructed or proposed for the Grand Canyon has been selected with a view to striking this blue lime at the most favorable point. By some inexplicable freak of nature, the blue lime at the point where the new trail strikes it is less impregnable inasmuch as the perpendicular portion of the formation is not over 30 feet in thickness. Below this vertical section the blue lime slopes off at an angle of approximately 60 degrees to the contact with the next underlying stratum. Down this slope a series of switchbacks takes the trail to the Tonto Plateau, where it connects at the "Tip-Off" with an existing trail leading down the sides of the granite gorge to the Colorado River.

The river at this point is crossed by the Kaibab suspension bridge, which is 420 feet long, 4½ feet wide, and designed only for pack- and saddle-animal traffic. This bridge is unique in that there is no other of its kind in the United States that spans so wide a stream as the Colorado. The next bridge over this river, upstream, is at Moab, Utah, a distance of 370 miles, while the nearest bridge downstream is the one between Topock, Ariz., and Needles, Calif., 385 miles away—a total of 755 miles with but one bridge. However, in this 755-mile stretch there are two ferries—namely, at Lees Ferry, 92 miles above the Kaibab suspension bridge, and at Cottonwood Valley, 311 miles below—by which automobiles may cross the river. After crossing the Colorado River, the route follows the box canyon of Bright Angel Creek by the trail already described in these pages, reaching the North Rim of the Grand Canyon and the Kaibab Forest after traversing a distance of 19 miles.

The total length of new construction from the South Rim to the Tip-Off is 4.60 miles, in which distance the drop is approximately 3,350 feet—making an average gradient of 13.9 per cent. The ruling maximum grade is 18 per cent., although there are three short stretches, of from 30 to 50 feet each, where the gradient necessarily had to be pitched up to 24 per cent. The total cost of the roadway up to date is $52,053.60—including the full initial cost of the air compressors and the other equipment purchased for the project. This makes an average cost per mile of $11,316.

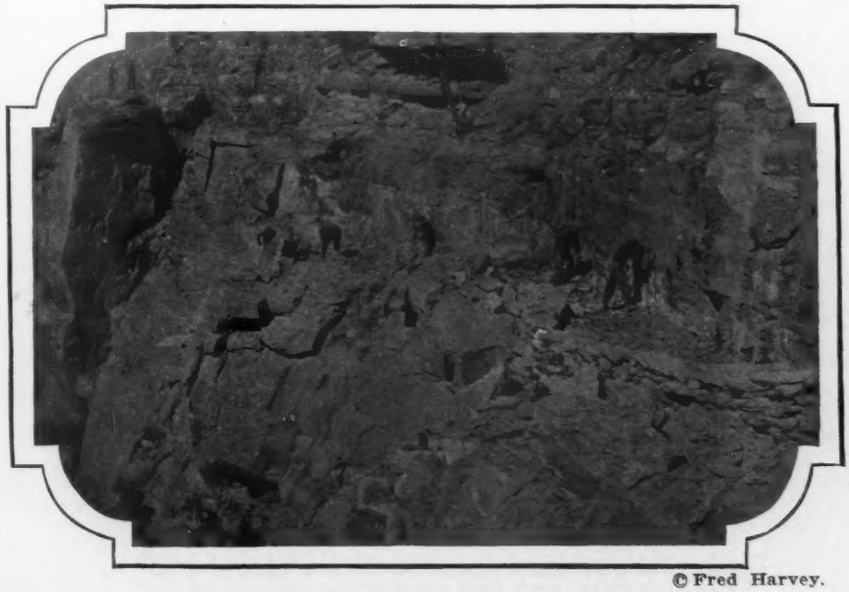
It is difficult to estimate what cost figure might have been reached had a similar trail been attempted without the use of modern air-power equipment; but it may be said that the figure would have been so great as to be termed prohibitive, and the Kaibab Trail would not now be a reality if it had been necessary to depend upon the old methods of single and double jacking.

MUD ACQUIRES INDUSTRIAL DIGNITY

SOMETHING other than mud must now be found to typify complete worthlessness, for mud has been given something to do; and the loading and the transporting of it in a semi-liquid condition have become an established business in the oil fields of California. It has been discovered that mud will serve a very useful purpose in the drilling of wells—the only requirement being that the material shall be as free from sand as possible.

In sinking a well, the drill generally passes through various strata of sand, which is in the habit of caving in and of filling up the well. To prevent this, it is becoming the practice in our western fields to plaster the walls of a well with fluid mud. Mud suitable for this work is obtained from a low spot in Wilmington, Calif., where a bed of fine, soft material 20 acres in extent and 12 feet deep is now being worked. A scraper drags the mud to a mixing plant, where it is stirred with paddles until it is ready to be pumped into tank cars for shipment.

A new caravan route from Mohammerah, on the Persian Gulf, to Teheran, opened late in the fall of 1925, will save from 11 to 20 days' time compared with the old routes.



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Starting through the ledge of Coconino sandstone.

WORK ON MOFFAT TUNNEL GOES STEADILY FORWARD

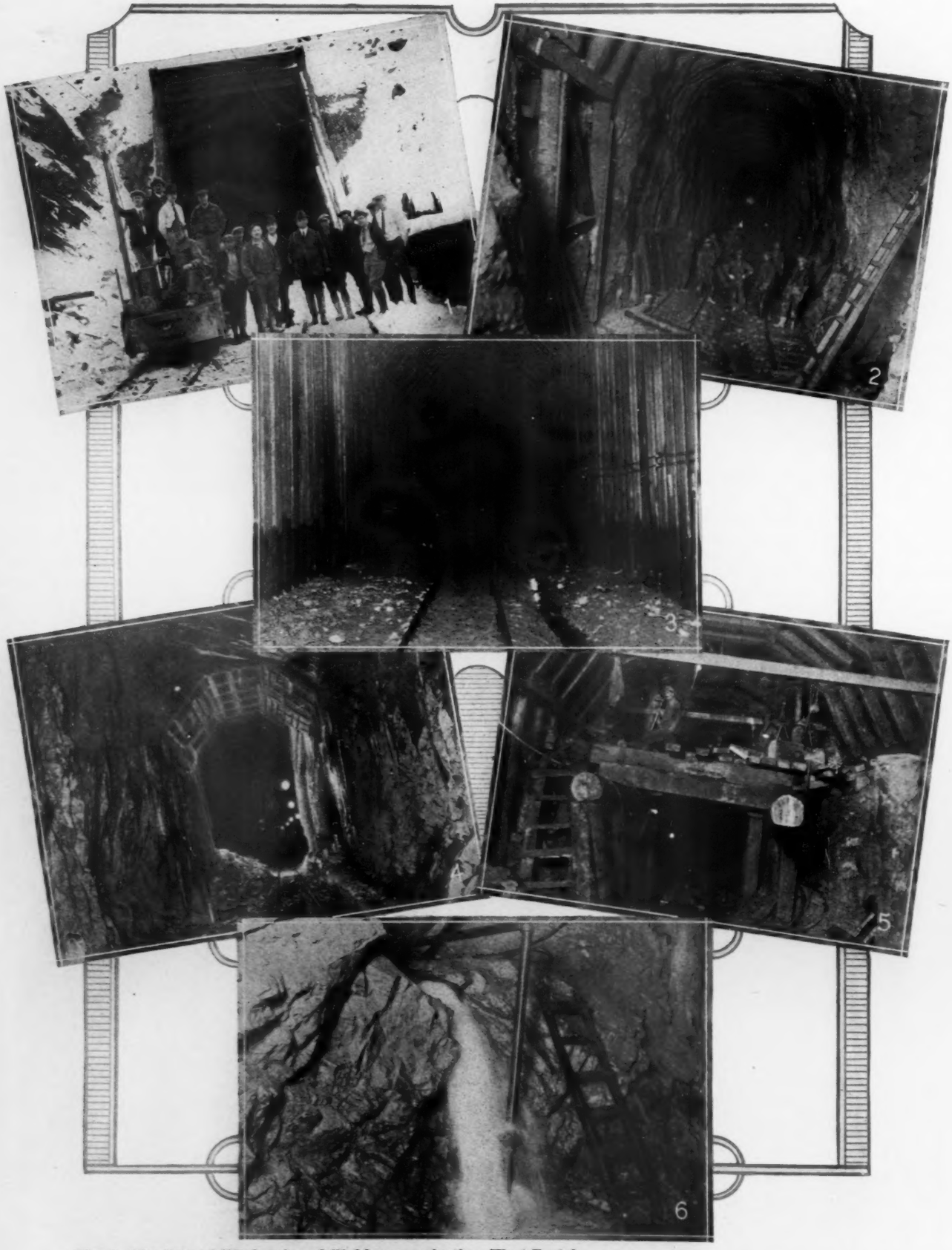


Fig. 1—Members of Hitchcock and Tinkler organization, West Portal.
Fig. 2—Railroad tunnel, in granite, with timber lining at seam in rock.
Fig. 3—Full-size section of railroad tunnel where heavy timber lining has been necessary because of soft rock.
Fig. 4—Railroad tunnel enlarged to full size, 16x24 feet, showing point where timbering has been necessary.
Fig. 5—Trapping muck from top widening, through jumbo set, to center heading.
Fig. 6—Water flow diverted from water tunnel to railroad tunnel through crosscut, East Portal.

America's Infant Diamond Industry

Some Thousands of Stones of a Superior Quality Have Been Found in Certain Parts of Arkansas

By GEORGE H. DACY

AMERICAN diamonds—6,000 of them, ranging in size from .2 to 20.25 carats—found among the mountains of Arkansas have put adventure and romance into a wild region which, otherwise, would be famous only for the viciousness of its rattlesnakes and the multiplicity of its chiggers. Imagine the thrill that would possess you if, riding muleback along a country road, your humble and dependable mount should chance to kick over a rock that glittered and glistened so brightly in the sunlight that you dismounted and picked up what turned out to be, on subsequent examination, a precious diamond.

That is what happened on August 1, 1906, to John Huddleston, of Pike County, Arkansas, who has the distinction of having found the first diamonds to come from that state. A few paces farther down the trail, on that memorable day, Huddleston found another piece of the same kind of rock. Later, he showed the curious specimens to neighbors, who suggested that they might be valuable. Ultimately, the farmer sent them to leading jewelers in New York and St. Louis who promptly pronounced them precious stones. One of the stones was a white diamond that weighed 4.5 carats and, even in those days, was worth about $600 in the rough.

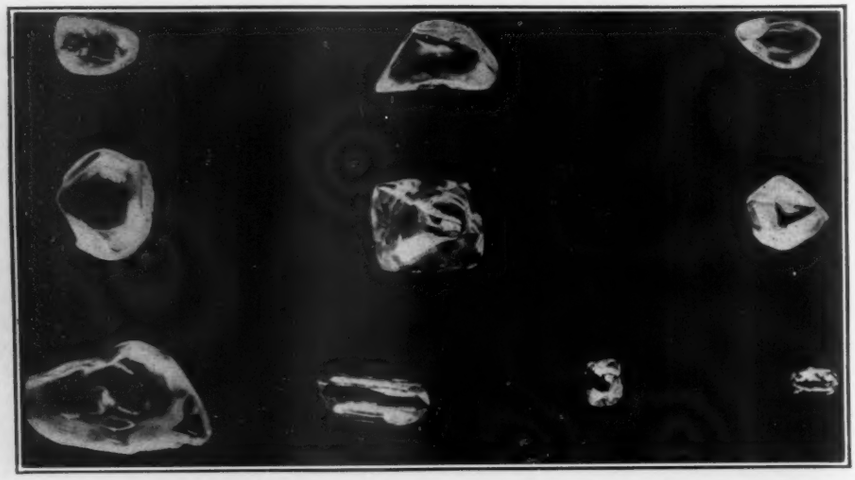
Huddleston immediately purchased the tract of land where he had discovered the diamonds; and afterwards sold his holdings for a large sum to a company of capitalists and jewelers. As a result of the diamond find, approximately 65 acres of land in 3 different tracts in Pike County were purchased by private companies; and these tracts are now being developed as five separate and distinct diamond mines. In recent years, a survey of the area has been made with the assistance of the experts of the United States Geological Survey; and, as an outcome of these investigations and studies, an American diamond industry is predicted to lend romance to a prosaic background of rice lands and hog farms.

The first authentic find of a diamond in the United States occurred about 90 years ago, when one of the precious gems was picked up by chance on an Indiana farm. Subsequently, on different occasions, one or more diamonds have been discovered in various sections of Virginia, North Carolina, Georgia, California, Idaho, Montana, Arizona, Michigan, Wisconsin, and Ohio. In none of these cases, however, was it possible to locate the source of the valuable gems. Attempts have been made repeatedly to trace the diamonds found in the glacial drifts of Wisconsin, Michigan, and Ohio to their sources, supposedly in Canada, but all these endeavors have been fruitless. The only diamonds found in America in their original matrix are those that have been uncovered in Arkansas, the state which has yielded more of these gems than any other region in the country.

Diamonds were discovered in California as early as 1849, soon after placer mining was begun—pale-yellow crystals, sometimes as large as peas, rewarding some of the prospectors who were hunting for gold. Later on, the gold gravels of Cherokee, in Butte County, California, became a famous source of "chance" diamonds. From that day to this, more than 500 sizable diamonds have been picked up by farmers, miners, prospectors, guides, trappers, and hunters; but, in gold-mining operations, many diamonds have probably been overlooked or destroyed. Some of the stones were small and "off color," but others were flawless and worth thousands of dollars. With the lapse of placer mining and hydraulicking, finds of diamonds in California became extremely rare. Geologists believe that those gems had their origin in the basic igneous rocks from which the serpentines of the gold regions were derived.

Even a score of years before the outbreak of

Left—Mill for treating the diamond-bearing rock of Arkansas.
Right—Lee Wagner standing by a sluice box such as is sometimes used in washing for Arkansas diamonds.
Bottom—Lee Wagner standing on the spot where John Huddleston found the first Arkansas diamond.



Collection of Arkansas diamonds owned by the late W. A. Roebling, who built the Brooklyn Bridge.

the Civil War, Arkansas was reputed to be a potential source of diamonds; but it was not until half a century later that the state geologist reported that he had found rock in Arkansas that was similar to the diamond-bearing rock of South Africa. Some time before, Kentucky had experienced an unsuccessful diamond rush akin to the California gold rush. In one way or another, the information had leaked out that some of the rocks of the Bluegrass region were of the diamond-bearing variety. The news was greatly magnified and distorted, and spread to all parts of the Corn Belt. Hordes of people hurried to Kentucky to seek their fortunes. A near-panic ensued. The would-be adventurers had only trouble for their pains, as none of them found diamonds. To prevent a repetition of this catastrophe, the state geologist of Arkansas was very chary about issuing reports as to the possible occurrence of diamond-bearing rock in Arkansas.

There was never any diamond rush to Arkansas, because private interests purchased all the properties on which gems had been found before the general public learned of this source of a short cut to fortune. Lee Wagner, employed as watchman by the Arkansas Diamond Company—the first mining industry of the kind to be established there—is, without question, the champion diamond hunter of America. During the last decade, he has picked up no fewer than 3,000 of these stones. Scientists say that Wagner apparently has a natural gift for "scenting" the uncut diamonds as they repose in the gem-bearing peridotite that abounds in Pike County. The largest diamond that Wagner has ever found weighed 17.87 carats, and at the time was worth at least $5,500 in the rough.

The diamonds of Arkansas are of volcanic origin. Scientists and geologists believe that, several million years ago, a subterranean volcano belched forth vast amounts of lava and rock which became the resting places of the precious stones that are now being mined there. Five diamond mines are located in the state, namely: the Kimberlite, the Mauney, the Ozark, the Arkansas, and the American, while another prospect at Black Lake is being worked—pits having been dug but no gems as yet uncovered. The Little Missouri River and Prairie Creek run through the region where the diamond fields are situated, and provide plenty of water for diamond-washing operations.

Peridotite in Pike County, Arkansas, which was blown from a volcano millions of years ago. The hat indicates a diamond-bearing stratum in this rock.

Most of the diamonds that have been recovered in Arkansas either have been picked up or reclaimed in washing plants or sluice troughs through which the soft, decomposed peridotite is washed. In some cases, drill holes and pits have been sunk as far as 205 feet below the surface, revealing layers of peridotite even at that depth. The geological conditions in Arkansas are quite similar to those that prevail in South Africa. The diamond returns, however, are radically different. In Arkansas, an average of 8 tons of material has to be handled in the recovery of 1 carat, while in South Africa only ¼ of this tonnage has to be handled to yield a 1-carat diamond.

In a twelvemonth not long gone, one of the Arkansas diamond mines produced 900 merchantable gems, while another yielded 1,500 diamonds during a 2-year period. Still another of the mines has to its credit an output of more than 3,400 diamonds since it was opened up. Even so, all these undertakings are still in a developmental stage. Processes must be perfected and adapted to serve local needs and conditions before a maximum reclamation is practicable. The average weight of 3,000 diamonds, whose records have been made public, was .4 carat, while the average weight of all the diamonds found in Arkansas is approximately .35 carat. Most of the diamonds are white, brown, or yellow. White stones represent a large proportion of the total production, and these are of high grade as to color, brilliancy, and freedom from flaws. Many of these stones are as fine as any discovered elsewhere in the world—in fact, they are equal to the best found in India or in the Jagersfontein mine in South Africa. Some of them, uncut, have been appraised at $600 a carat.

The Arkansas diamonds do not occur in clusters or in volcanic pipes as do those in the South African mines; and in Arkansas, diamond mining is done exclusively in open pits, a procedure that is radically different from that followed in the South African fields. There, diamonds are found 3,600 feet below the surface—many of the best stones coming from deep down in the bowels of the earth. Hydraulic mining has been practiced in Arkansas to a small extent, but most of the recovery has been by hand and by the use of plows and scrapers. In hydraulic mining, the water carries the disintegrated diamond-bearing rock through a sluice trough, from which the concentrates are removed and then jigged by hand in small sieves. After the jigged concentrates are placed on smooth sheets of metal, they are carefully gone over for diamonds. Much of the material that has been mined has had to be hauled in small tram cars to the washing plants.

Washing pans of the type in common use in the South African diamond fields have been employed. The pan is a circular affair with a flat bottom, at the center of which is a vertical, revolving shaft having toothed radiating arms. As these arms revolve, the diamond-bearing material in the pan is stirred, thus causing the diamonds and the associate heavy minerals

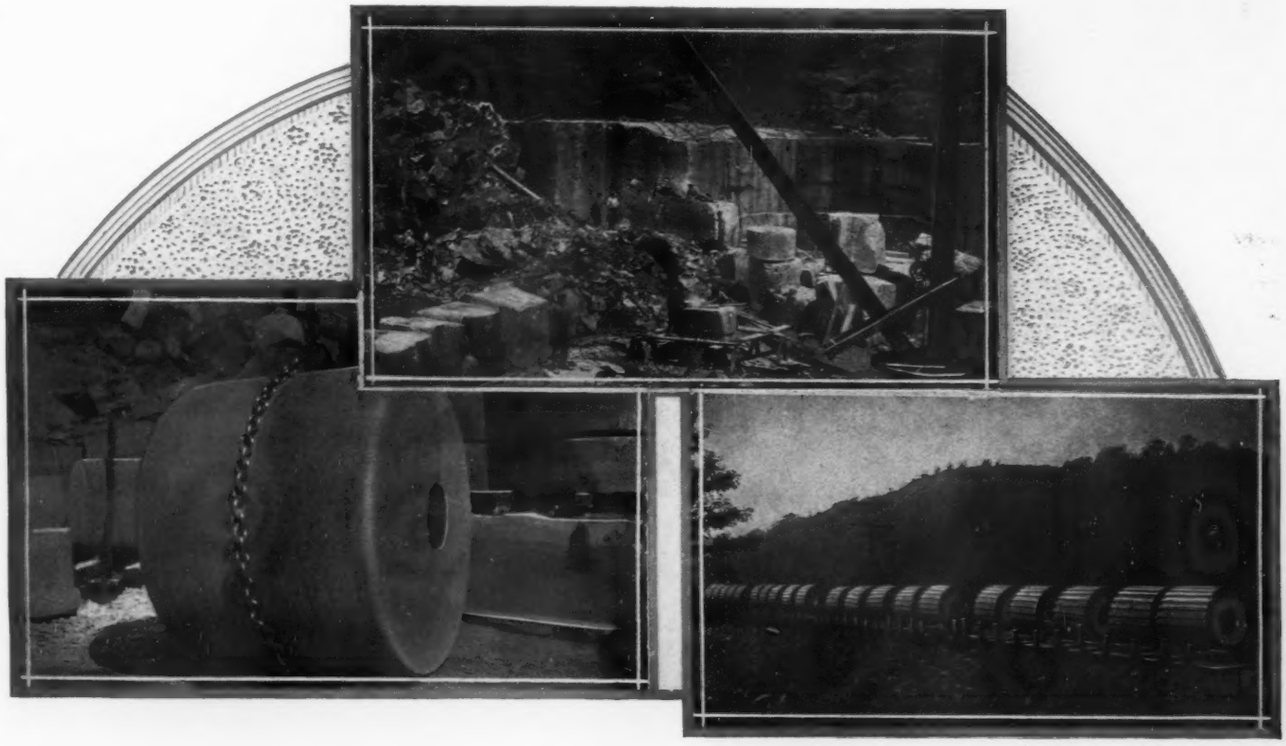
gradually to settle to the bottom of the pan while the clay and other lighter minerals rise to the surface and are carried off. The concentrates obtained in this way are then sized and jigged. The jigged concentrates are next spread on metal-covered tables where they are carefully examined for diamonds, or recovery is effected by washing the concentrates over a table, covered with a thick film of grease, which is shaken rapidly from side to side by an eccentric. As the concentrates pass across the table, the grease holds the diamonds while the foreign matter is washed away. The diamond-bearing grease is then removed, and the precious stones are reclaimed by converting the grease into soap.

ground into small particles by holding the timber against a huge revolving circular stone. This grinder is appropriately called a pulpstone; and in the following short description we will attempt to show how pulpstone is quarried and dressed for use in paper mills.

On the outskirts of the small town of East Liverpool, Ohio, is located a pulpstone quarry owned by the International Pulpstone Company. Here the stone is not only cut out of the natural rock but is shaped into the finished product. The pulpstone, which is composed of a siliceous sandstone, lies in a horizontal bed, 18 feet thick, that is covered with an overburden of shale, slate, and soil ranging in depth from 30 to 60 feet.

quarried, the subsequent treatment is as follows: the rough cubes are made to conform as closely as possible to the shape and the size desired in the finished article. This is done with Type 3-R chipping hammers, with moil-point chisels, which chip out holes, about four inches apart, along the line of the desired break. Small iron wedges are next inserted in the holes and driven home by means of sledge hammers. The chipping hammers, with the moil points, are also used to finish the surfaces of the two flat sides and to round off the peripheral edges, thus forming a rough cylinder-shaped block.

Now the stone is ready for treatment in the mill. But before it can be given its final



Photos. Courtesy, Smallwood Low Stone Company.

Top—Siliceous sandstone quarry at Opekiska, W. Va.
Left—This pulpstone is one of the largest made and has a diameter of 67 inches.
Right—A trainload of pulpstones on their way to a paper mill.

In the rough and rugged sections of mountainous Arkansas, where the diamond-bearing peridotite exists, rattlesnakes abound, and knee-top boots are, of necessity, regulation footwear of the diamond miner. If he be fortunate enough to escape the poisonous bites of the venomous reptiles, he has still another pest to contend with—the millions of chiggers that worm their way under the skin of the victim and cause him untold annoyance. Thus it can be seen that the life of the diamond prospector, even though he operates in these modern days of airships, automobiles, radio, and other conveniences, is not without its terrors.

QUARRYING AND DRESSING PULPSTONES

IN the manufacture of paper from pulpwood, one of two methods is employed in the initial process. By one method the rough logs are cut into small chips by means of a cutting machine, and by the other the logs are

To reach the stratum of pulpstone, "Jackhamer" drills are first employed to remove the rocky overburden. When this is done, the exposed stone is drilled with the same "Jackhamers" at intervals of from six inches to a foot along the side of the desired break. A slow-acting explosive, such as black powder or dynamite, is then placed in each of the holes and fired—the stone breaking into roughly shaped cubes measuring, generally, anywhere from 3 feet square to 6 feet square.

We might mention here that where the nature of the sandstone is somewhat different, the blasting method has to be discarded. For example, at the quarry of the Smallwood Low Stone Company, of Opekiska, W. Va., it has been found necessary to put channelers to work in getting out the original blocks. For this purpose a 7-inch, electric-air track channeler is employed.

No matter by what method the stone is

dressing in a lathe, it must have a square hole so as to permit placing the cylinder on a square lathe shaft. This hole, which is approximately 5x5 inches square, is made by drilling 4 holes with a "Jackhamer"—one hole in each corner of the 5x5-inch square. The material within the square is broached out by hand with a flat chisel. As the stone slowly revolves against the lathe tool, which is controlled by the action of a lever, it is machined to a perfect cylinder, such as is shown by one of the accompanying illustrations.

And now we come to the last stage of the process by which the rough material from the quarry is turned into the finished pulpstone. The stone must be given a center hole of prescribed shape and size. This hole is usually round and about 10 inches in diameter, with the opposite openings funnel-shaped. The cutting of this hole is done with the type of chipping hammer already mentioned.

Oil-electric locomotive making good in winter service.

OIL-ELECTRIC LOCOMOTIVE IN WINTER SERVICE

THE first snowstorm of the season invariably develops new and unusual sights on the streets of New York City. Judging by the curiosity displayed by passersby, one of the most interesting of the scenes this year was the 60-ton oil-electric locomotive recently placed in service by the Baltimore & Ohio Railroad Company.

Although covered with icicles, and barely visible at times through the blowing snow, this new type of railroad motive power proceeded on its imperturbable course hauling freight trains on and off floats in the Hudson River at the foot of West 26th Street. That this locomotive is economical as well as efficient was strikingly attested recently when it made a run of 733 miles, unattached, at an average fuel cost per mile of only one and two-tenths cents—less than the average fuel cost per mile of most automobiles.

BIG AIR COMPRESSOR AT MT. CLARE SHOPS

*By G. O. Moores**

AMONG the many changes which mark the progress of the development of shop practices in modern railway locomotive and car repair shops, one of the most interesting is the increasing number of ways in which compressed air is used in rebuilding and conditioning rolling stock. Power of that kind is particularly adaptable to working steel; and as large locomotives and steel cars are fast replacing the small "locos" and wooden cars of former days, compressed air is being used in greater quantities at all modern railroad shops.

In order to keep pace with this power trend at Mt. Clare, our management authorized, in December, 1924, the purchase and installation of a compressor, the capacity of which is the largest on the system. After a careful analysis of the bids submitted by various manufacturers, the order for the machine was placed during the latter part of last January, and preparations were made for constructing its foundation. A suitable site was found in the east end of the substation building, where convenient connections could be made to the electrical supply lines and to the air distribution mains in the boiler and erecting shops.

Because of its location on the main floor of the substation building, with a cellar space underneath, special foundation arrangements were necessary to take care of the machine's weight (120,000 pounds) and to absorb the shock of its heavy reciprocating parts. The concrete floor of the building was cut away for a space about 20 feet square and a solid block of concrete was built up from the cellar floor, with additional deeper footing courses at the ends.

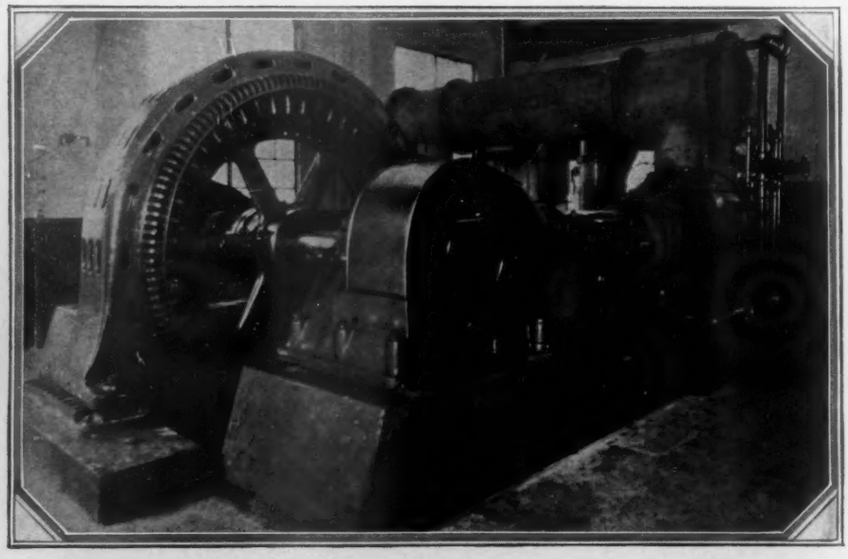
Following modern practice, where there is available an economical and reliable source of electricity, the compressor is motor driven by an engine-type synchronous motor with its rotor mounted directly on the compressor crankshaft. This forms the most efficient connection possible between the prime mover and its load. Excitation for the fields of the motor is furnished by a motor-generator set, and the starting and the stopping are performed by a reduced-voltage automatic starter with push-button control.

The compressor was delivered on June 19, and was erected, piped up, and turned over on July 14. After a few days' tuning up, it was placed in service on the shop load on July 20, a record performance for a machine of that size.

With a displacement capacity of 5,070 cubic feet of free air per minute, with the cylinder and rod dimensions of a locomotive, and driven by a 900-H.P. motor running at 156 revolutions per minute, the unit symbolizes modern progress in the furnishing of power for railway-shop operations.

The installation was made under the supervision of J. H. Davis, chief engineer of electric traction, the work being handled by the writer, ably seconded by field inspector George K. Yost.

**Assistant Engineer, Electrical Department, Baltimore & Ohio Railroad.*



This Ingersoll-Rand compressor, at the Mt. Clare shops, is the largest one in service in the Baltimore & Ohio Railroad system and has a piston displacement of 5,070 cubic feet a minute.

Reprinted by courtesy of Baltimore and Ohio Magazine.

The construction of an electric railway in the Hautes-Alpes, France, begun in 1910 and interrupted on account of the World War, is being pushed actively, and the present indications are that the road will be put in service at the end of 1927. Besides expediting the transportation of agricultural products, the line will open up mineral resources that have remained untouched heretofore because of a lack of shipping facilities.

Putting Power of Georgia's Rivers to Work

Terrora Development is One More Link in a Chain of Stations on Tallulah and Tugalo Rivers

PART I

By JAMES E. O'ROURKE*

THE development of the water-power resources of the Tallulah and Tugalo rivers, in Rabun and Habersham counties in northern Georgia, has shown rapid progress since the organization of the Georgia Railway & Power Company in 1911. The growth of power production in the southeast was steady from 1902 on, but the development of Georgia's latent power possibilities did not receive a real impetus until shortly before 1912. Then it was that the Georgia Railway & Power Company acquired the necessary lands and water rights in the Georgia mountains and proceeded to utilize the power in the Tallulah River.

The project attracted nationwide interest at the very start because the Tallulah Falls power house, the first to be constructed there, was to operate under a head of 608 feet which, at that time, was the highest head of any plant east of the Rocky Mountains. In its production of power, the company will use the waters of the Tallulah and the Tugalo rivers six times. Most of the energy now produced passes through a giant switching frame on the mountain above the Tallulah Falls plant, and is sent thence over the 936 miles of transmission and distribution lines to all parts of northern Georgia.

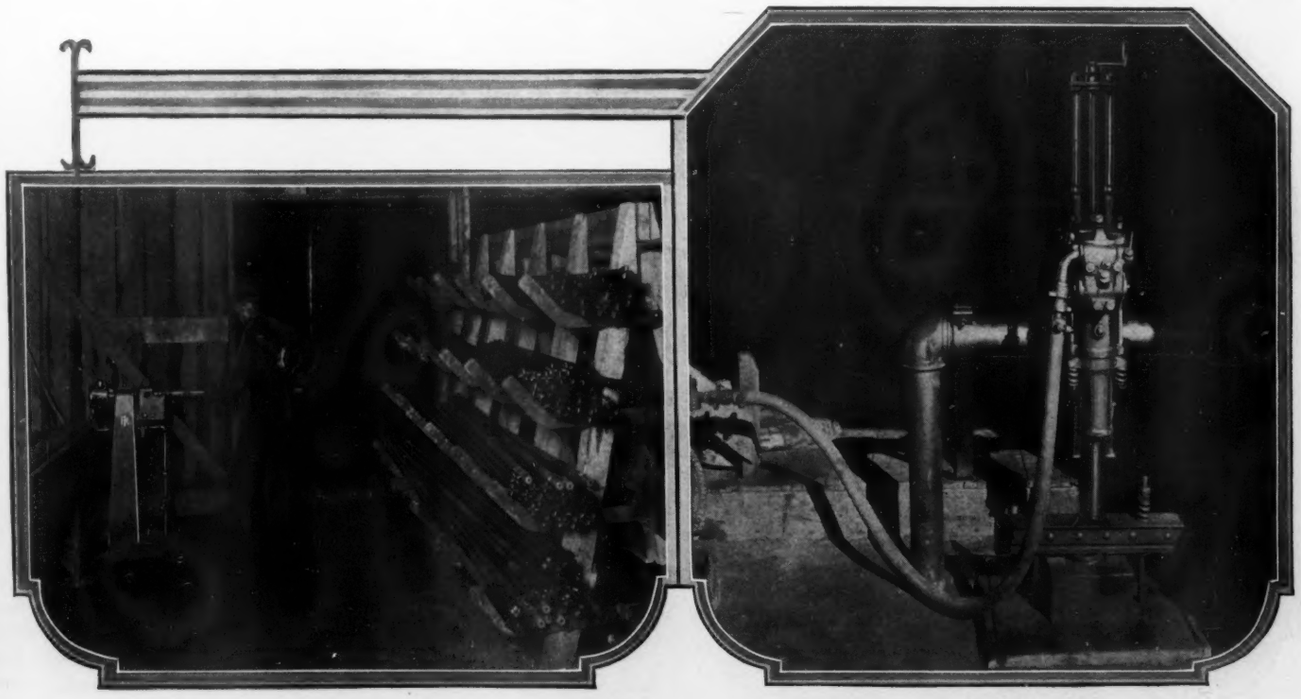
HYDRO - ELECTRIC power plants have been playing for some years a big part in bringing about an industrial revolution in certain sections of the South. This is conspicuously true in the case of Georgia; and the accompanying article describes the latest efforts in this field of engineering in that enterprising state.

One of the most interesting phases of this work is the skilful way in which the descending waters of two rivers are used over and over again by the Georgia Railway and Power Company to generate electric current which is distributed far and wide to substantially seventy communities. These rivers will produce annually the equivalent of 531,000,000 kilowatt-hours of electric service.

The Tallulah development consists of a cyclopean-masonry dam, 116 feet high and approximately 400 feet long at its crest, built across the Tallulah River above the falls. The water is diverted through a tunnel, 6,666 feet long and cut in solid rock, to a surge tank at the top of the gorge above the power house, from which the water is passed to the wheels in the power house below through 6 steel penstocks, each of which is 5 feet in diameter and about 1,200 feet long. The generating equipment consists of six 18,000-H.P. water turbines, of the reaction type, directly connected to 12,000-Kw. generators of the vertical type.

Mathis Dam and reservoir, 6 miles above Tallulah by river distance, was the second development in the system. This dam is built of reinforced concrete, and is 90 feet high and 700 feet long. The lake thus formed has an area of 834 acres, holding 1,369,000,000 cubic feet of water, equivalent to 15,000,000 kilowatt-hours at the Tallulah Falls plant and 3,940,000 kilowatt-hours at the Tugalo plant.

Resident Superintendent, Terrora Development.



Left—Drill-sharpening shop showing a No. 8 pedestal grinder in the background.
Right—Test rack used in the repair shop to test drills before re-issuing them for service.

The X-70 drill proved extremely efficient in driving the Terrora Tunnel.

Putting lifters in a bench with I-R rock drills.

A group of X-70 drifters at a heading in the Terrora Tunnel.

Burton Dam, at the head of the system, was the next one to be constructed. This dam is 116 feet high, 1,250 feet long, and forms a reservoir covering 2,775 acres capable of holding more than 5,000,000,000 cubic feet of water—equivalent to 55,000,000 kilowatt-hours at Tallulah Falls and 13,850,000 at the Tugalo power house.

The Tugalo Dam and power plant went into operation under full load in April of 1924. This development is located on the Tugalo River just below the confluence of the Tallulah and Chattooga rivers, and the great dam stands 140 feet high and is about 1,000 feet in length. The power house is equipped with 4 water wheels, each of 22,000 H.P., that operate under a head of 150 feet. The rated output of the plant under normal conditions is 140,000,000 kilowatt-hours per annum. The area of the reservoir is 557 acres and has an impounding capacity of 500,000,000 cubic feet of water.

Work has recently been completed on two other developments, namely, those known as the Terrora and the Yonah projects; and it is of the Terrora development that we shall deal at some length and in considerable detail because of certain engineering phases of that undertaking. However, before doing so, it might be just as well to tell briefly something about the Yonah project. This undertaking is located on the Tugalo River, 3 miles below the Tugalo plant, and backs the water upstream to the tailrace of the Tugalo plant. The dam is 75 feet high, about 900 feet long, and the power house is equipped with 3 water wheels, each of 12,500 H.P. and connected with a vertical type generator of 8,333 Kw. The plant utilizes all water passing the Tugalo power house and coming from the storage reservoirs on the Tallulah as well as the partly regulated flow of the Chattooga River.

The Terrora project is the connecting link between Mathis and Tallulah lakes; and the object of the development is to divert the water so obtained through a tunnel, approximately a mile in length, and to drop it through steel penstocks to a power house located at the upper end of Tallulah Lake—thereby utilizing for power purposes an available head of 190 feet. The Terrora power house has a generating capacity of 20,000 Kw. and an estimated annual output of 63,800,000 kilowatt-hours.

Mathis Lake, having a reservoir capacity of 1,369,000,000 cubic feet, was created on the completion of Mathis Dam in 1914. Since that time, Mathis Lake has functioned solely as a storage reservoir from which the water has been drawn, as required, to maintain the proper elevation of Tallulah Lake. The water passing through the gates in Mathis Dam follows the tortuous channel of the Tallulah River for a distance of 5 miles and empties into Tallulah Lake about 50 yards below Sawtooth Falls. Considered from a construction standpoint, Terrora development has presented several interesting problems; and, for the purpose of description, might properly be divided into six different parts or units, namely: Intake structure, main tunnel, surge tank, penstock tunnel, penstocks, and power house and transformer station.

The intake structure, which required 4,000

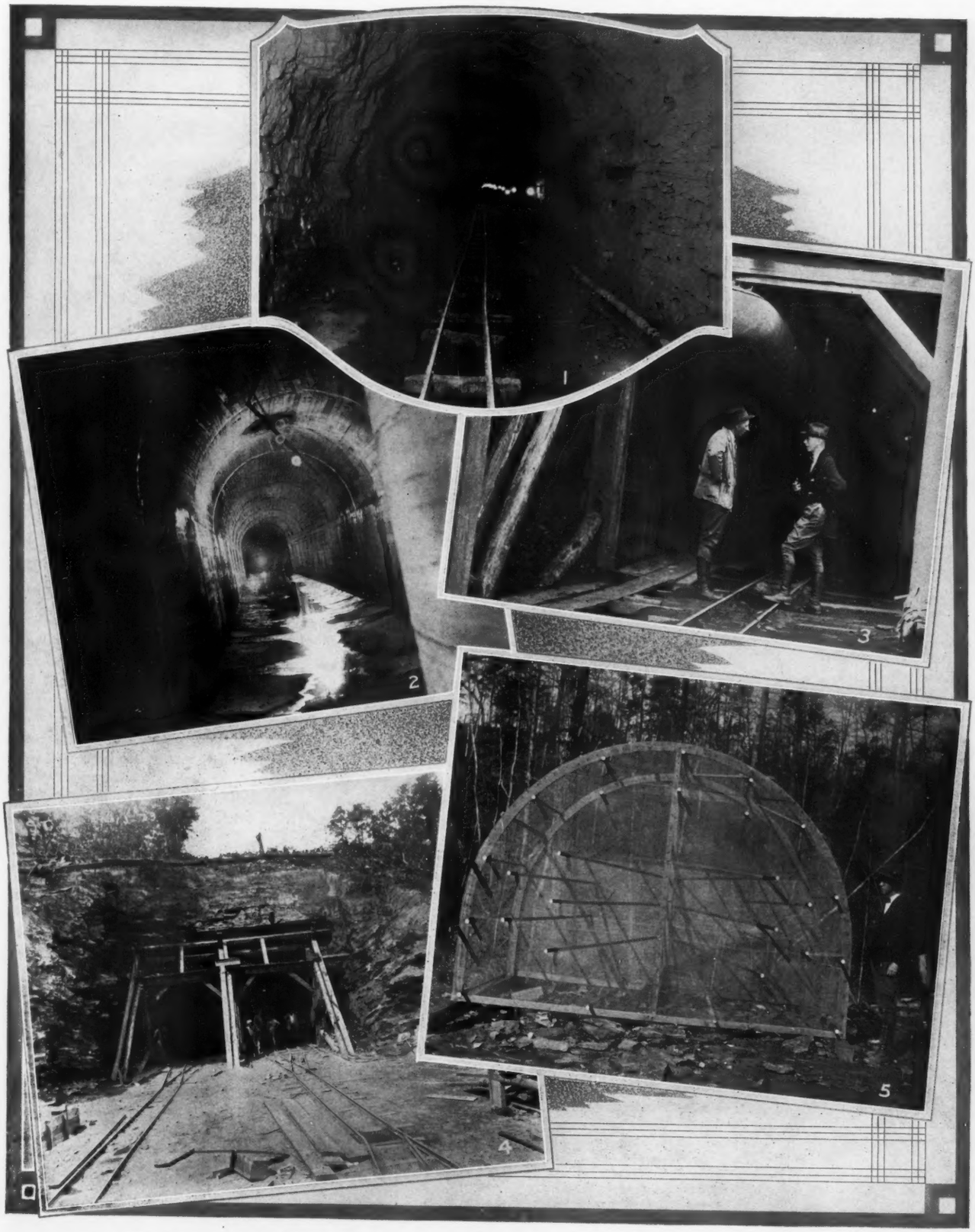


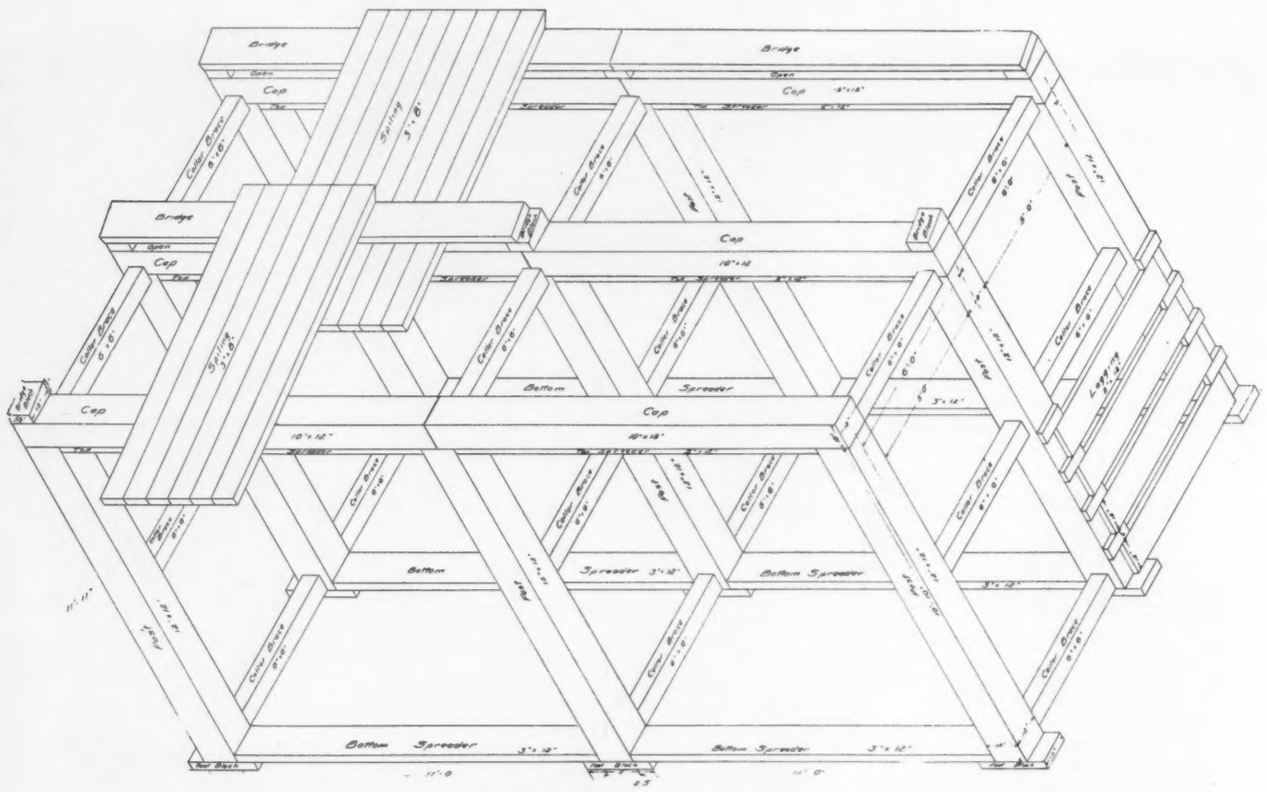
Fig. 1—This unlined section of the tunnel indicates what can be accomplished by careful drilling and blasting.

Fig. 2—Concrete-lined tunnel section, looking eastward from the intake structure.

Fig. 3—Conference on the job at one of the portals. Note inflated "Flexipipe" used in ventilating the tunnel.

Fig. 4—Tunnel portal at Sawtooth end of the project.

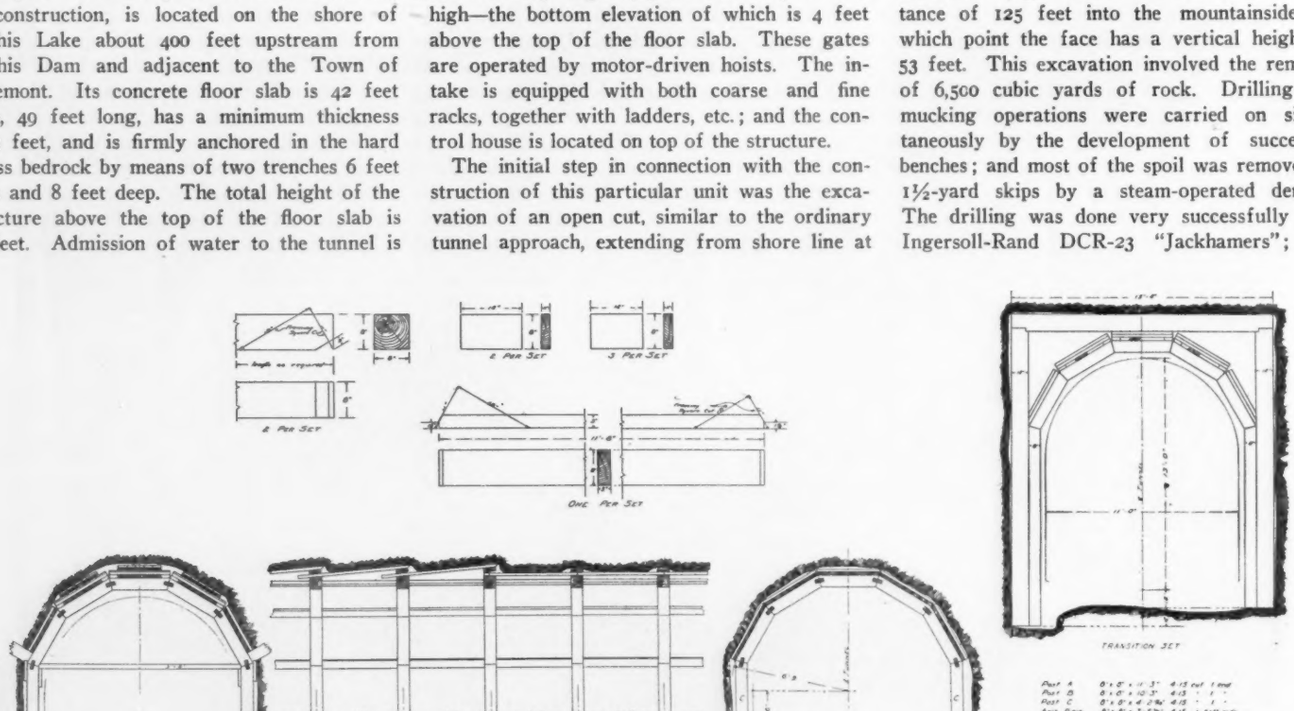
Fig. 5—This model of the tunnel heading was used to show the drillers how to space and to drive the holes.



Isometric sketch of timber set for penstock section of the tunnel.

cubic yards of heavily reinforced concrete in its construction, is located on the shore of Mathis Lake about 400 feet upstream from Mathis Dam and adjacent to the Town of Lakemont. Its concrete floor slab is 42 feet wide, 49 feet long, has a minimum thickness of 3 feet, and is firmly anchored in the hard gneiss bedrock by means of two trenches 6 feet wide and 8 feet deep. The total height of the structure above the top of the floor slab is 55 feet. Admission of water to the tunnel is controlled by 2 gates, 9 feet wide by 12 feet high—the bottom elevation of which is 4 feet above the top of the floor slab. These gates are operated by motor-driven hoists. The intake is equipped with both coarse and fine racks, together with ladders, etc.; and the control house is located on top of the structure.

The initial step in connection with the construction of this particular unit was the excavation of an open cut, similar to the ordinary tunnel approach, extending from shore line at Elevation 1,637—bottom of floor slab—a distance of 125 feet into the mountainside, at which point the face has a vertical height of 53 feet. This excavation involved the removal of 6,500 cubic yards of rock. Drilling and mucking operations were carried on simultaneously by the development of successive benches; and most of the spoil was removed in 1½-yard skips by a steam-operated derrick. The drilling was done very successfully with Ingersoll-Rand DCR-23 "Jackhamers"; and



Details of timbering used in the main tunnel.

Hercules No. 1 Special dynamite was used in the shooting operations.

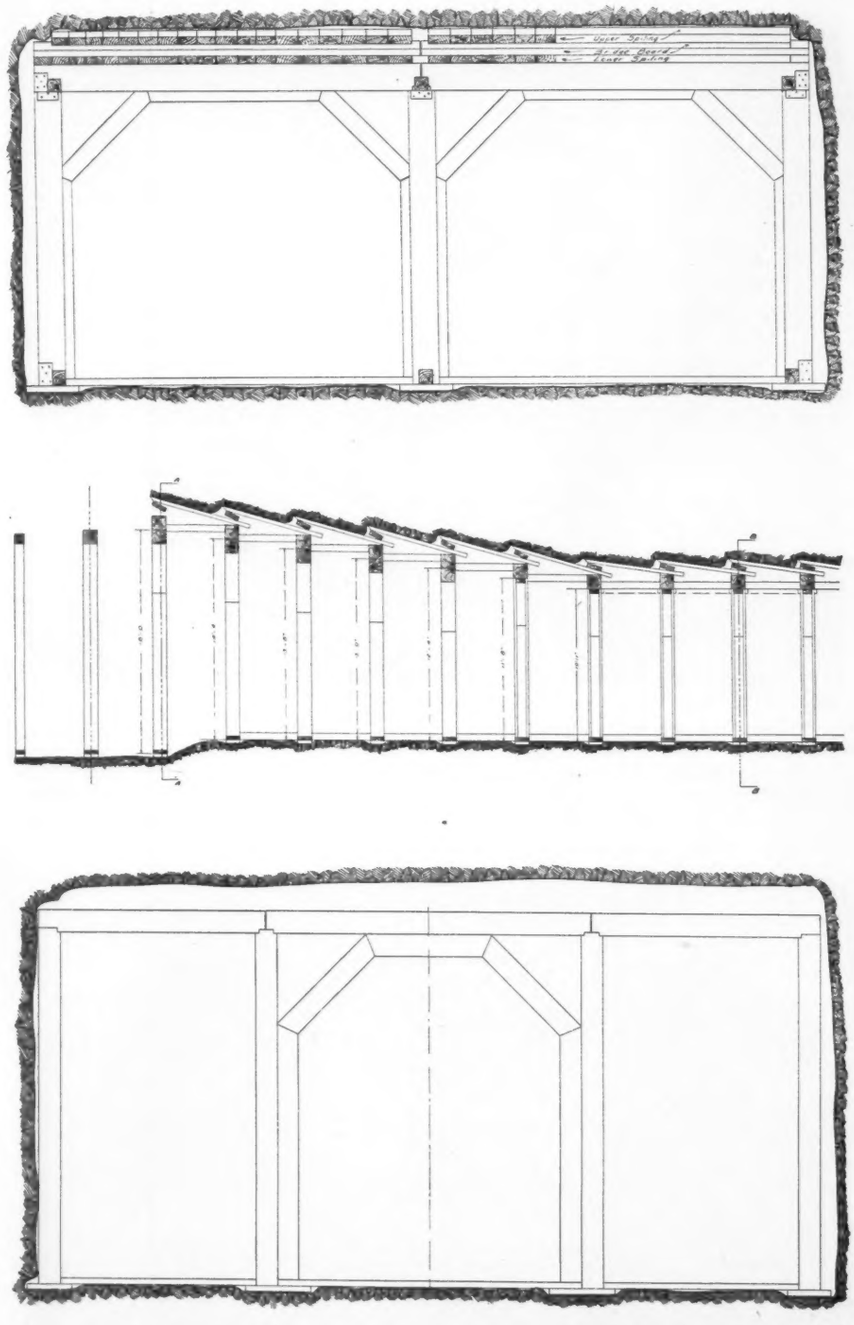
In order to convey material to this end of the project, two miles of standard-gage railroad were constructed. This line connected with the Tallulah Falls Railway at a point midway between Lakemont and Joy. It was necessary to build two bridges on the line—one of which spanned the Tallulah River and the other crossed a deep gorge almost directly over the portal of the Lakemont adit. This spur terminated at a point on the mountainside above the top elevation of the intake structure; and, owing to the extreme difference in elevation above the roadbed of the Tallulah Falls Railway, a switchback, with a 5 per cent. gradient, was employed that necessitated the excavating of two deep cuts through hard rock for a distance of 400 feet. Skirting the hillside near the intake site, a side cut was excavated through rock for a distance of 375 feet. All drilling on this railroad excavation was done with the type of "Jackhamer" already mentioned, using 1-inch, hollow, hexagon drill steels; and Hercules No. 1 Special was used in blasting.

Crushed rock for concreting was secured from a crushing plant erected alongside the railroad. This plant was equipped with a No. 4 McCully gyratory crusher, a 40-foot belt elevator, and a revolving screen 10 feet long and 42 inches in diameter. The tunnel muck was dumped directly from tunnel cars to a chute leading to the crusher hopper, and the trommel screen was erected at a sufficient elevation to permit the crushed product to flow by gravity through a hinged chute directly to 1½-yard skips mounted on the decks of standard-gage flat cars.

Clean river sand was obtained from a sand trap located on Tiger Creek, about one mile above Lakemont Station on the main line of the Tallulah Falls Railway. A No. 4 Morris dredge pump delivered the sand from the trap to standard-gage steel cars equipped with hopper bottoms. The railroad transferred the loaded and the empty cars to and from our siding, and our 30-ton locomotive completed the delivery over the spur line.

This crushed rock and sand were unloaded from cars to separate storage bins located below the track level and fed by gravity to the charging hopper of a ½-yard mixer. Cement was stored in a warehouse erected alongside the track and was delivered to the charging hopper through a gravity chute. The concrete was mixed in proportions of 1:2½:5; and delivery from the mixer to the forms was accomplished by means of a steam-operated derrick handling 1-yard, bottom-dump buckets.

The main tunnel bore extends in an easterly direction from the intake structure for a distance of 5,269 feet, and there the tunnel is connected to the surge tank. This bore is 15 feet high by 13 feet wide, and has an arched roof having a radius of 6½ feet. The side walls from spring line to floor grade are perpendicular. Close cross-sectioning showed that the actual size of the finished tunnel was practically 10 per cent. greater than the area computed from the foregoing dimensions with the exception of the first 25 linear feet adjoining the intake wall, which was excavated 19 feet wide and 21 feet high to provide space for a reinforced-concrete lining 4 feet thick.



Sketches illustrating the timbering used in the surge tank and in the penstock tunnel.

The total excavation in the main tunnel bore amounted to 38,089 cubic yards.

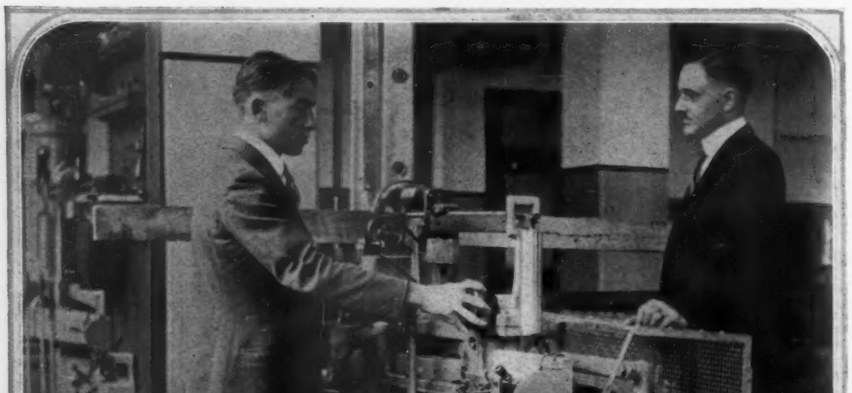
This work was started in July of 1923; and it was impossible to make a direct attack at the intake portal, at the Lakemont end, as this would have involved the draining of Mathis Lake with a resulting loss of water representing millions of potential kilowatt-hours. Consequently, it was decided to drive a 327-foot adit about 300 feet downstream from Mathis Dam. In excavating the approach to this adit, advantage was taken of a natural gorge which had to be widened and deepened for the purpose of securing sufficient width for haulage and drainage and for getting the necessary grade. We also had to trim the side of the gorge to provide room for locating the blacksmith shop, the change house, the drill repair shop, etc.

(To be Concluded)

HOLDING POWER OF SCREWS DETERMINED

WHAT is the holding power of a given wood screw? In order to answer this question once and for all, I. J. Fairchild and D. Aronowsky, of the United States Bureau of Standards, have conducted extensive tests with more than 10,000 screws of varying kinds and sizes. These screws were driven into seven different kinds of wood, including yellow poplar, cypress, sycamore, Georgia pine, North Carolina pine, hard maple, and white oak. In making these studies, various other factors—such, for example, as a lubricant or a lead hole, that might have a bearing on the holding power of screws—were taken into consideration. The machine used by the investigators in arriving at the desired figures is shown in the accompanying photographs.

Until these tests were undertaken, it was impossible to tell just how many pounds of pulling force it would take to get a screw of a given size out of a certain kind of wood. But now, thanks to the painstaking efforts of the Government scientists, accurate data—the first of its kind on the subject—are available. To the thousands of woodworking establishments in the country this information should prove of inestimable value, as it will enable them henceforth to use just the right kind of a screw for a certain kind of work made of a certain kind of wood.



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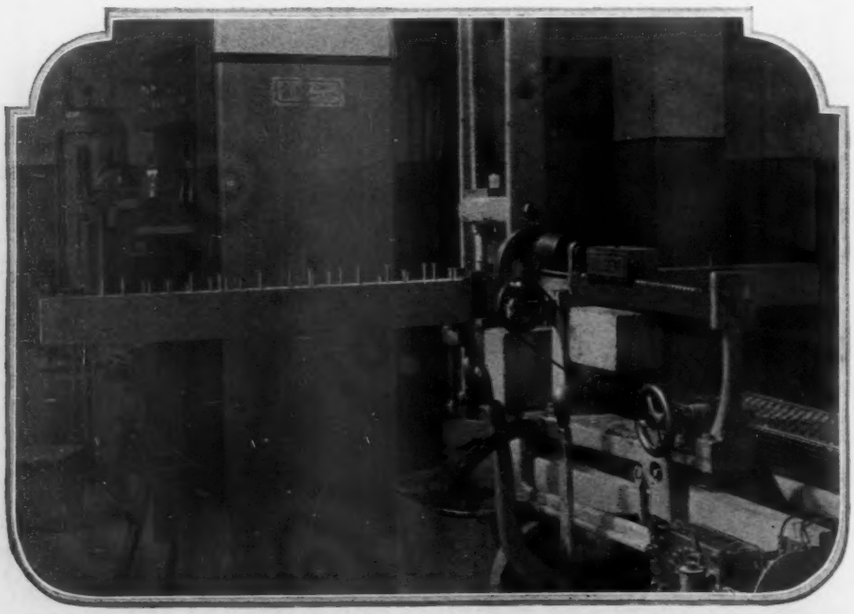
Apparatus used by the United States Bureau of Standards in testing the holding power of more than 10,000 screws.



A piece of wood with numerous screws inserted ready to be run through the testing machine to ascertain the holding power of the screws.

WAYS DEVISED TO INCREASE OIL-WELL OUTPUT

A WAY by which oil sands may be made to yield petroleum more generously has been suggested by Prof. Lester C. Uren, of the University of California. He discussed this in a paper read before the American Institute of Mining & Metallurgical Engineers. Professor Uren proposes that the output of petroleum may possibly be increased by enlarging the diameter of wells. He bases his belief on certain laboratory work in which compressed air was utilized to enlarge the well cavity in experimental sands. Furthermore, the author showed in some detail how obstructing sand might be removed from a full-sized well by utilizing an adaptation of the compressed-air lift or ejector.

It is a well-known fact that less than half the oil in the average oil-bearing sand is recovered by the methods commonly employed in bringing the petroleum to the surface. Accordingly, petroleum engineers and others interested in this subject are giving much thought to devising practical means or methods by which a larger percentage of the oil in a pool or well may be withdrawn. This is an important move, because it is wasteful to do the work essential to tapping a pool or oil-bearing sand only to leave behind so much of the available petroleum. Any improvements in the methods of recovery should be encouraged.

Professor Uren has pointed the way to better results; and in this work he is ably seconded by the labors of other technicists. There is every reason to believe that apparatus and methods will be perfected belong long which, if applied widely, will insure ample oil to meet all our needs for many years to come.

RICH SILVER-LEAD STRIKE IN QUEENSLAND

THE Government of Queensland is intent upon making the most of its natural resources; and one step in this direction is the recent authorization of a railway to Mt. Isa, where there are extremely rich deposits of silver, lead, and zinc. It is said that the Mt. Isa district bids fair to yield even more richly than Broken Hill, in New South Wales, which, for more than four decades, has been world famous as a silver-lead producer.

According to the *Christian Science Monitor*, "The government geologists' estimate of the life of the Mt. Isa mineral field is approximately a century." Furthermore, we learn from the same source, that "one of America's leading experts in metallurgy and mining engineering recently spent some weeks at Mt. Isa inspecting the various ore bodies with a view to advising the management as to the most suitable methods of metallurgical treatment to be adopted."

Making a Suburban Ice Plant Successful

Sweetwater Ice and Fuel Company Demonstrates What May be Gained by Adopting Oil-Engine Drive

By CHESTER J. CONN

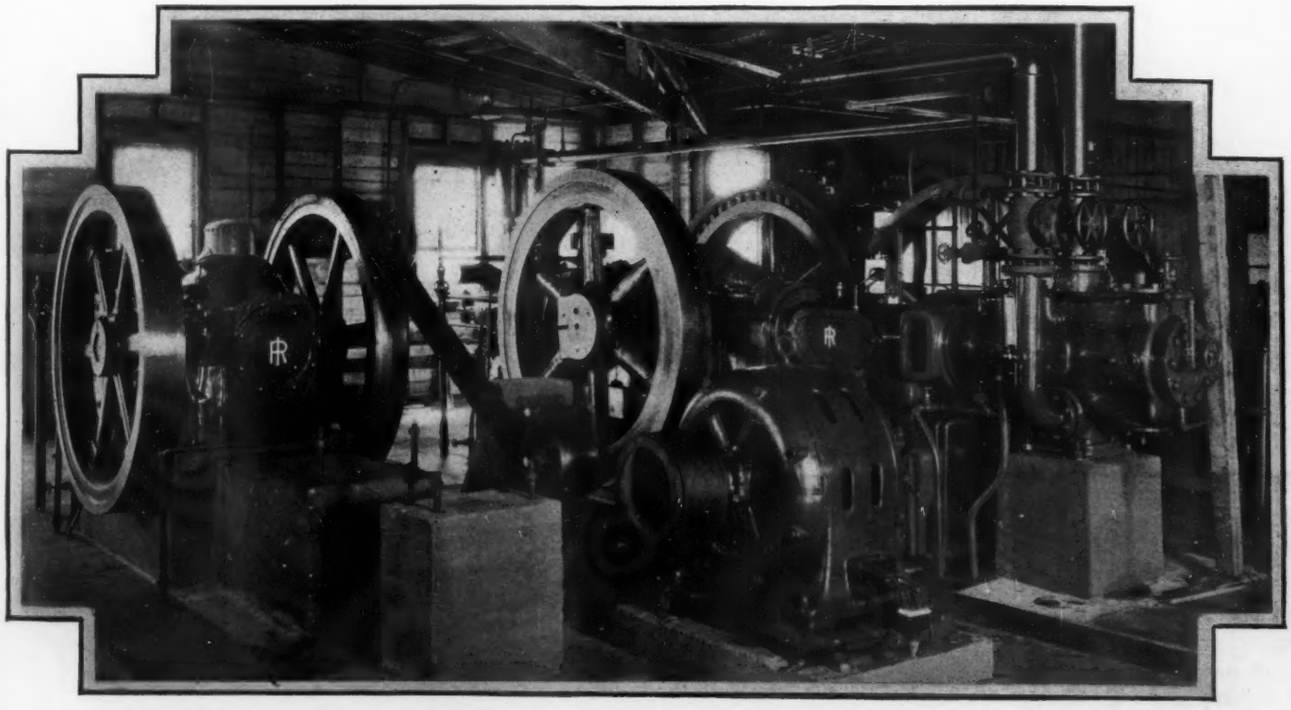
SMITHTOWN is situated near the north shore of Long Island and about a three hours' run by rail from New York City. The place was settled first more than a century ago; and many of the surviving houses plainly indicate their antiquity. Besides being centrally located in relation to a goodly number of other communities that look to Smithtown for some of their material comforts, Smithtown is adjacent to many handsome homes or country places that also draw upon that place for one thing or another. Ice is one of the commodities so demanded.

Prior to 1913, all ice used in the neighborhood was obtained from local ponds, and, naturally, the quality and the quantity of this ice were wholly dependent upon the severity or the mildness of the winter season. If the harvest was a scant one, then, as soon as the harvested ice was exhausted, the supply was maintained by ice shipped in by rail. Manifestly, this state of affairs was not infrequently anything but satisfying. At times, the incoming ice did not arrive soon enough to obviate inconvenience and discomfort; and, invariably, ice so delivered cost considerably more than the locally harvested commodity.

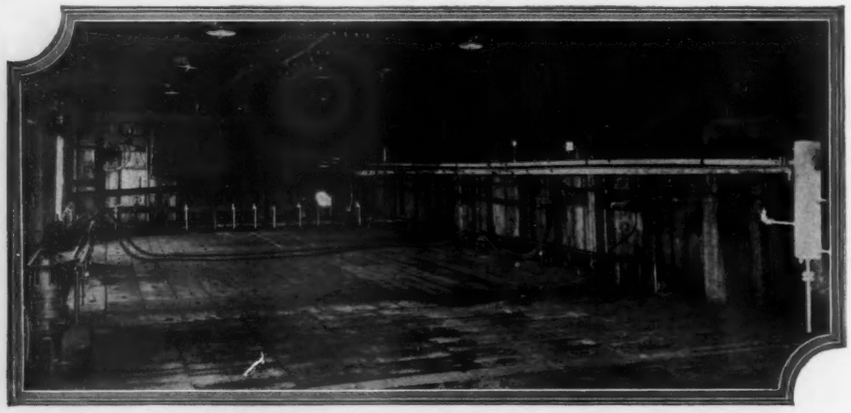
With the growth of Smithtown and the increase of population in the surrounding country, it became self-evident that steps should be taken to insure a sufficient supply of ice to meet the local requirements, and it was equally needful that this supply should be independent of winter conditions and to be had at moderate prices. These requirements could be met only by establishing an ice-manufacturing plant in Smithtown; and this was done in 1913 when the Sweetwater Hygeia Ice Company was organized. That company operated for only three years, and the plant thereafter remained idle for three years until it was sold to the present owners, the Sweetwater Ice & Fuel Company.

REFRIGERATION and real estate, as businesses, may not at first blush seem to be interrelated; but, even so, property values are invariably enhanced by any cause or condition that contributes to the well-being or the comfort of local inhabitants. This axiomatic assertion applies certainly in the case of Smithtown, Long Island. Mechanical refrigeration has proved a boon to that community; and the benefits of ice made there by up-to-date facilities have spread far and wide throughout a radius that embraces numerous other towns and villages. The present article tells, in part, what oil-engine drive makes possible in the way of operating economies in what might properly be termed isolated plants.

When the business changed hands, the plant was equipped with an oil engine that was belted to an 11½x22-inch ammonia compressor which had a daily ice-making capacity of about 18 tons. The fuel cost then averaged about 40 cents a ton of ice produced. At that time, that was rightly considered an excellent performance for the unit in question; and the operation of the plant continued substantially on that basis until August 13, 1922, when the engine broke its crankshaft. Occurring right in the middle of the peak-load period, there were urgent reasons why the manufacture of ice should be interrupted for the shortest practicable period. Unfortunately, the management could not obtain a replacement shaft for the



This view of the plant shows the two oil-engine units in place. In the foreground, at the left, is seen the foundation upon which will be placed the second ammonia compressor.



The ice tank of the Sweetwater Ice & Fuel Company.

engine in less than 90 days; and the crisis could be met successfully only by substituting electric drive—it being possible to obtain and to install a motor within a comparatively short while.

The motor was bought and was ready to begin operating on September 26—current being obtained from a public-service line at 3 cents a kilowatt or at the rate of $1.86 per hour. The electric motor was able to drive the ammonia compressor somewhat faster than the old oil engine so that the compressor was able to produce 20 tons of ice daily instead of giving an output of only 18 tons, as was the case when the original prime mover was in service. However, the power cost, with purchased electric current, was increased to $2.23. While the substitution of electric drive made it possible for the plant to resume operations after a shutdown of but 44 days, still, as the foregoing figures show, power cost for producing ice was increased more than 500 per cent. As might be expected, the management was desirous of bettering its operating conditions; and the surest way to do this, apparently, was by returning to oil-engine drive. The only question was to determine upon that type of oil-engine drive which promised best to meet the needs of the plant and the growing demand for ice.

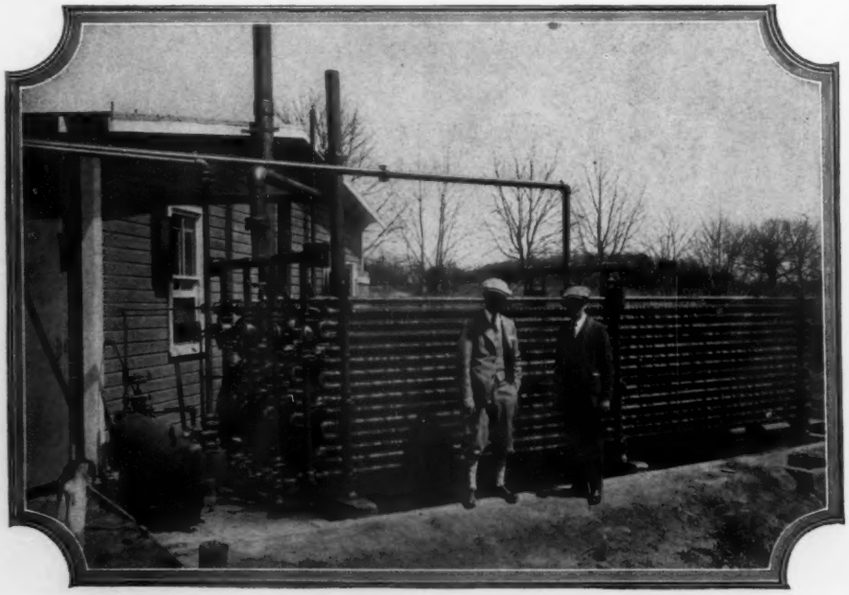
The management of the Sweetwater Ice & Fuel Company had, for years previously to the organization of that company, been intimately identified with the refrigerating machinery business, and was, therefore, intent upon selecting the best that the industry could offer. Accordingly, the decision was in favor of equipping the plant with a direct-connected, oil-engine, ammonia-compressor unit having a refrigerating capacity of 66 tons. Furthermore, in order to make the plant entirely self-contained, an oil engine of 50 B.H.P. was bought to drive, by a short belt, a generator of 35-kilowatt capacity. The current from this generator is used to provide light for the plant and to operate various auxiliary motors which are installed in the plant for one purpose or another.

The oil-engine, ammonia-compressor unit is of the well-known POC-1-A type, in which a horizontal oil-engine cylinder is directly opposed to a horizontal ammonia-compressor cylinder—an arrangement that makes a very efficient means of power transmission. In short, the unit is a notably compact one, very accessible, and easy to handle. The efficiency of the machine can be readily appreciated when it is recalled that the manufacturer's guarantee specifies a fuel-oil consumption of not more than 0.62 pound per hour per ton of refrigeration—based on a suction pressure of 20 pounds and a discharge pressure of 185 pounds in the ammonia cylinder. Expressed in another way, with fuel oil weighing 7½ pounds per gallon, this means that a ton of ice can be produced at an expenditure of less than 4 gallons of fuel oil.

The oil-engine half of the unit has a single-acting cylinder, employing direct injection of the fuel and operating upon the 4-stroke cycle. An injection pump delivers the fuel oil, at a suitable pressure, to two opposed spray nozzles; and the forcible commingling of the two sprays so effectually atomizes the oil as to promote instant and complete combustion of the fuel when the heat of compression reaches the inflaming point. This arrangement makes it possible to dispense with high-pressure air for fuel injection; and the system of ignition also obviates the need of hot bulbs, electric coils, or any other kindred equipment for starting or for firing the charge during running periods.

The refrigerating end of the unit is a double-acting, single-stage ammonia cylinder of cast iron that must pass a shop test at a hydrostatic pressure that is more than twice the pressure under which the cylinder is called upon to operate in service. The barrel and the cylinder heads are so water-jacketed as to reduce the heat of compression and to insure efficient lubrication. Both the intake and the discharge ports are equipped with Ingersoll-Rand plate valves, which operate with a minimum of clearance. These valves are tight when seated, are rapid and positive in their action, and their efficiencies are of a very high order. A hand-operated by-pass valve serves to unload the compressor when starting; and this makes it possible for the oil engine to start without load—a relatively small amount of compressed air serving to get the engine running.

Compressors of the POC-1-A type are built to operate normally with a suction pressure of from 15 to 20 pounds and with a discharge pressure ranging from 150 to 210 pounds per square inch. Inasmuch as plant conditions may vary and the working pressures at times be so increased as to overload the oil engine, this overloading is prevented by an ingenious expedient, called a clearance pocket, that acts in such a way as to produce a condition that is virtually equivalent to reducing the capacity of the compressor cylinder. The clearance pocket makes it feasible to run a compressor under varying load conditions having a considerable range. Not only that, but the clearance pocket enables the oil engine to pick up its full load gradually from a standstill. Without entering into details, it might be mentioned that the 50-



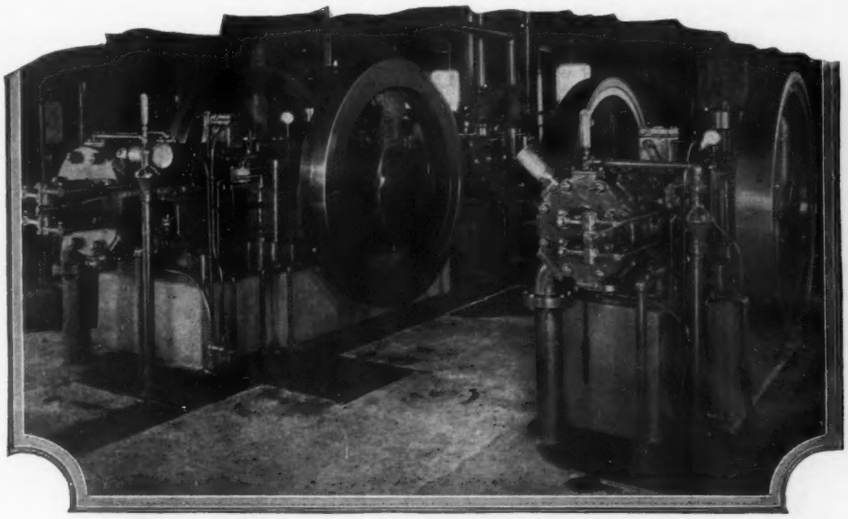
Open type of ammonia condenser installed at the plant of the Sweetwater Ice & Fuel Company. Mr. Hiram J. Conn and his son, Chester J. Conn, members of the company.

H.P. oil engine now in the plant of the Sweetwater Ice & Fuel Company duplicates in its working principles the distinctive features of the oil-engine end of the ammonia compressor unit. That is to say, the engine is simple in design; capable of meeting the demands of a wide range of service; economical in its fuel consumption; and thoroughly dependable.

The two oil-engine units in the Sweetwater plant were installed in December of 1924; and, in order to take advantage of the greater capacity of the POC-1-A machine, the tank capacity of the plant was increased so as to make it possible to produce 30 tons of ice daily. Both the ice-making unit and the 50-H.P. engine are operated on a combined hourly expenditure of 3½ gallons of fuel oil, which costs 7 cents a gallon. In other words, the fuel for both engines does not cost more than 24½ cents an hour. The management estimates that ice is being made on a fuel-oil consumption of 2.8 gallons per ton of ice. Therefore, with a fuel expenditure amounting to 24½ cents per hour for power, as against an outlay of $1.86 cents an hour formerly paid for electric current, the present plant is effecting an hourly saving aggregating $1.615! Manifestly, this means a very substantial economy in the course of a season's run.

In answer to a query from another ice plant, the management of the Sweetwater Ice & Fuel Company made this statement after the two units at Smithtown had been operating for the better part of a year: "Outside of replacing a check valve in the spray nozzle on the small engine, we have not had to make any repairs or replacements. If you are contemplating the purchase of an oil-engine-driven ammonia compressor, you will make no mistake in installing an Ingersoll-Rand unit. We have operated other types of oil engines, but we have found no other make so simple to operate."

Until recently, the Sweetwater Ice & Fuel Company had only a very limited storage capacity, and was, therefore, unable to make the most economical use of its ice-making equipment. Latterly, an addition has been made to the plant in the form of a 2,500-ton ice-storage house; and the intention is to amplify the facilities by providing a cold-storage department. The cold-storage annex will have a capacity of approximately 18,000 cubic feet, and will be used for fruits and vegetables. The neighboring section of Long Island is a very productive trucking region in which are grown root vegetables, such as turnips, carrots, beets, and potatoes, as well as cauliflower, peppers, and spinach, while the orchards yield an abundance of peaches and apples in favorable seasons.



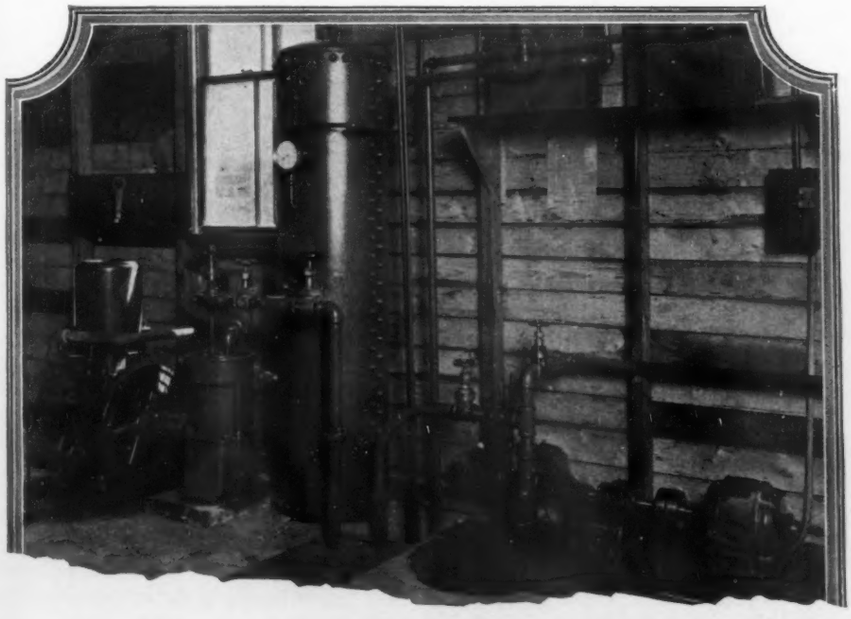
The unit at the left is the Ingersoll-Rand 66-ton oil-engine ammonia compressor which carries the main refrigerating load. The oil engine at the right, of the same make, drives the 35-kilowatt generator which furnishes electric current for the plant.

When installing the 50-H.P. oil engine, which drives the 35-kilowatt generator, another foundation was built on which a 33-ton POC-1-A ice-making machine could be mounted. This smaller unit, which will soon be in place, will carry the refrigerating load of the ice-storage and the cold-storage departments, as well as a part of the ice-tank load, as occasion may require.

The water used at the plant is obtained from a well 104 feet deep; and this water is so free from suspended matter that it is not necessary to pump out and refill the cores of the ice cakes during the final freezing period. The water in the cans is agitated with low-pressure air—using a deep-tube system for agitating. Two cans are pulled at a time; and there is an interval of 36 hours between filling and pulling. The chloride-of-sodium brine is maintained at a temperature ranging from 10° to 12°F.

The community immediately supplied by the Sweetwater Ice & Fuel Company consists of Smithtown and Smithtown Branch, but the service district lies within a circle having a radius of 15 miles, and includes many neighboring towns. Plans are well matured for the creation of a service and supply station at Northport, about 10 miles away. This station is to be equipped with a small automatic electric refrigerating machine which will have sufficient refrigerating capacity to take care of an ice-storage room that will be big enough to accommodate 400 cakes. A 5-ton truck and trailer, having a capacity of 101 cakes, will carry the ice from the Smithtown plant to the service station at Northport.

The Sweetwater Ice & Fuel Company is located in a part of Long Island where the population is a pronouncedly fluctuating one. This is because the district attracts a large influx during the summer season. Accordingly, the management of the plant has had to provide equipment which would economically take care of a widely differing demand. As has been pointed out, the company has been successful in this; and the assurance of a plenty of ice at all times has had a beneficial reflex upon living conditions and property values within the territory served.



Starting air for the oil-engine units is furnished by an I-R Type 15 vertical compressor driven by a small Novo engine.

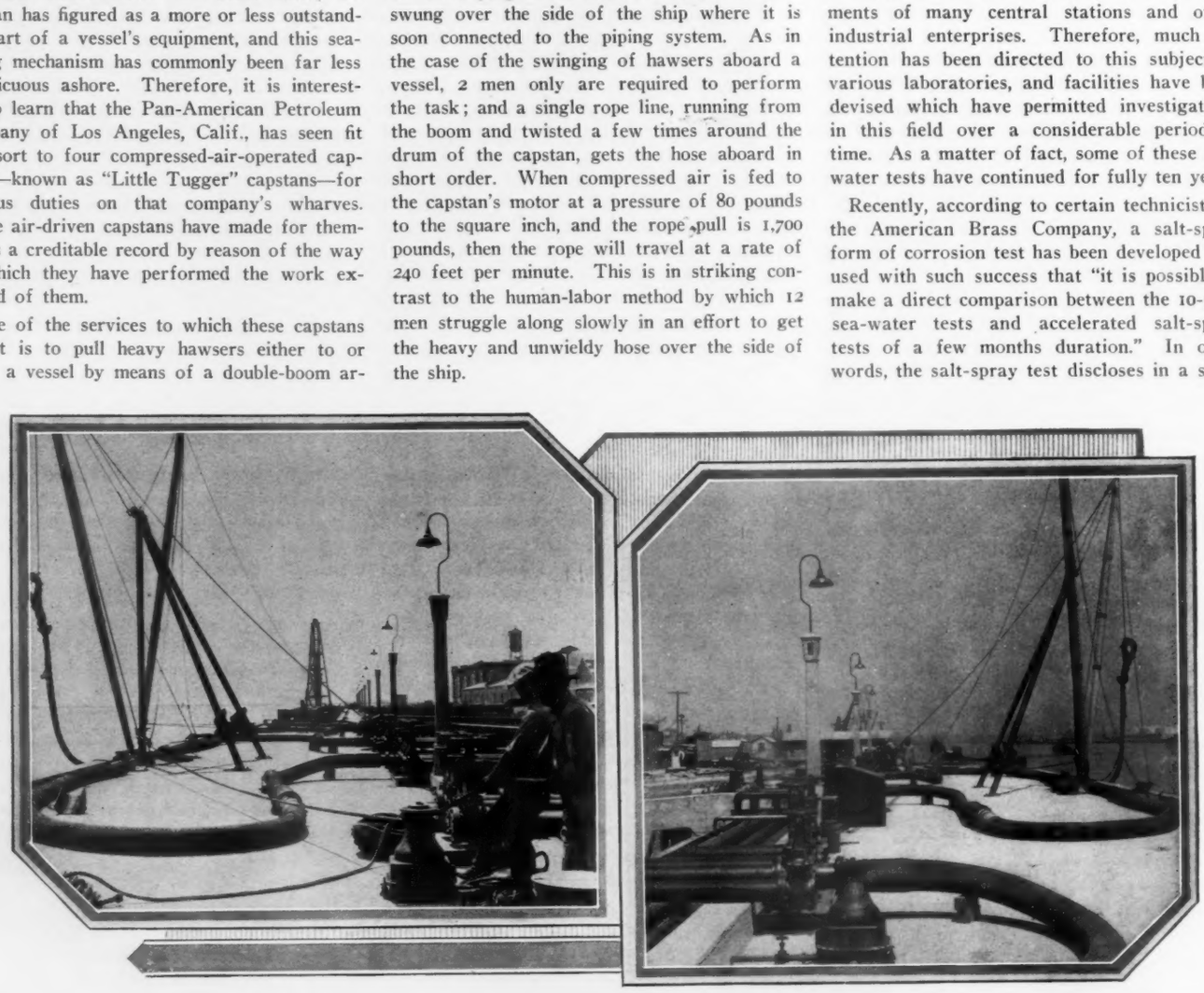
AIR-DRIVEN CAPSTAN MEETS A NEED

FROM the romantic days of "sail"—so thrillingly portrayed by Marryat, Melville, Russell, and others—down to recent times, the capstan has figured as a more or less outstanding part of a vessel's equipment, and this seafaring mechanism has commonly been far less conspicuous ashore. Therefore, it is interesting to learn that the Pan-American Petroleum Company of Los Angeles, Calif., has seen fit to resort to four compressed-air-operated capstans—known as "Little Tugger" capstans—for various duties on that company's wharves. These air-driven capstans have made for themselves a creditable record by reason of the way in which they have performed the work expected of them.

One of the services to which these capstans is put is to pull heavy hawsers either to or from a vessel by means of a double-boom arrangement, which is illustrated in one of the accompanying photographs. The operating speed and the pulling power of capstans of this type are noteworthy. After one end of a hawser has been carried to a ship and fastened to one of the vessel's bitts, then the other end is wound two or three times around the drum of the most convenient of the dock capstans, and, finally, air is admitted to the capstan motor. Two men perform the work of taking in the slack of the hawser as the drum revolves, and the ship is thus drawn alongside the wharf.

In unloading or loading a tanker lying at the dock, the oil is transported through heavy, flexible hose that is usually from 10 to 12 inches in diameter, but this hose must first be lifted over the side of the ship and connected with a pipe line leading to the vessel's pumping plant. When handled in the ordinary way, it often takes as many as 12 men to do this work. By contrast, the air-operated capstan makes child's play of such a job.

By means of the double boom, the end of the hose, lying on the dock, is neatly lifted and swung over the side of the ship where it is soon connected to the piping system. As in the case of the swinging of hawsers aboard a vessel, 2 men only are required to perform the task; and a single rope line, running from the boom and twisted a few times around the drum of the capstan, gets the hose aboard in short order. When compressed air is fed to the capstan's motor at a pressure of 80 pounds to the square inch, and the rope pull is 1,700 pounds, then the rope will travel at a rate of 240 feet per minute. This is in striking contrast to the human-labor method by which 12 men struggle along slowly in an effort to get the heavy and unwieldy hose over the side of the ship.



Air-driven capstans, of the 7-H Type, in service on the wharf of the Pan-American Petroleum Company at Los Angeles, Calif. These capstans are used to lift and shift the heavy hose employed in unloading tankers as well as to handle the hawsers by which the vessels are secured alongside the pier.

The work of capstans of this type is in no wise confined to docks; they can be utilized for any task requiring a straight pull, such as would be needed in shifting or switching cars or in moving bulky materials. In fact, they can take the place of air-driven hoists whenever heavy rope is necessary to do the pulling, inasmuch as the drum of a capstan will readily accommodate sizes of rope that cannot be handled so effectually by the drum of a hoist.

To facilitate the transportation of ore from their mines high up in the Andes Mountains, the Vanadium Corporation has had a railroad built to their workings, in Peru, lying 15,500 feet above sea level. Before the road was put in service, the ore had to be packed on the backs of llamas for a distance of 28 miles to rail head.

RATE OF CORROSION TESTED WITH SALT SPRAY

THE corrosive action of salt water on the condenser tubes of large power plants is a matter of serious concern to the managements of many central stations and other industrial enterprises. Therefore, much attention has been directed to this subject in various laboratories, and facilities have been devised which have permitted investigations in this field over a considerable period of time. As a matter of fact, some of these sea-water tests have continued for fully ten years.

Recently, according to certain technicists of the American Brass Company, a salt-spray form of corrosion test has been developed and used with such success that "it is possible to make a direct comparison between the 10-year sea-water tests and accelerated salt-spray tests of a few months duration." In other words, the salt-spray test discloses in a short while phenomena that might otherwise require a much longer period to furnish the same data. Furthermore, salt-spray tests can be regulated so as to simulate closely the physical conditions under which condenser tubes work from week to week with changing factors.

According to Messrs. W. H. Bassett and C. H. Davis, the salt-spray apparatus consists of an inclined Alberene stone box covered with a glass plate and fitted with a spray nozzle operated by compressed air. They tell us: "The salt-spray test affords a convenient and satisfactory means for the study of the rates of corrosion for continuous periods of different lengths. It is also indicative of the true relative resistance of the alloys, whereas in the sea-water tests the initial rates of loss were very low, for instance in the case of Muntz metal, and consequently misleading."

Mechanical Equipment Lighten Labor and Lower Costs in Excavating

By H. A. WOODWORTH, M. E.

PRIMITIVE man used his hands to excavate with. Then, later, he used twigs and tree limbs to dig a cave in the hillside for his abode. Still later on, as keeper of the sacred fire, he saw to it that the community had a light wherewith to maintain fires in their homes. By thus having furnished the community with warmth and fire for many purposes, in other words, by having kept the home fires burning, he should now be recognized as the first "public utility." As centuries passed, communities were similarly supplied with water, fire, and provisions, until man of primitive days developed into such men as Harriman, Insull, and the like.

Trenching in busy streets must be done rapidly so as to interfere as little as possible with traffic. Therefore, portable compressors and air-driven tools are now used for this work.

The community of fifteen years ago received its water, gas, and electric light through underground conduits. All excavations were then made with pick and shovel. Later, when the excavating of paving became common, to tear it up with hand pick, sledge, steel points, etc., at the higher wages paid made it very costly to install conduits of any kind.

The writer has had years of experience in hand excavating as compared with excavating by machinery, such as by trenching machines; and he has seen large utilities, that formerly did all such work by hand, change well-nigh over night to power machinery for excavating, breaking up paving, moving material to and from the job, raising and lowering conduits, mixing concrete and placing it in trenches, etc. While such machinery is coming more and more into use, the writer believes that people generally take too much for granted, and that some comparisons and examples should prove of interest.

The introduction of modern concrete paving made the cost of removing such paving very high and excessive. Consequently, in endeavoring to find a speedier, more economical, and efficient method of removal, the paving breaker—operated by a portable air compressor—was devised and brought into play. This equipment proved to be a great improvement, and cut the cost of excavating materially.

The pneumatic-tool manufacturer developed his tools to a high degree of efficiency and dependability; and has now so arranged his machinery that it can be mounted on any kind of truck, such as the work may demand. One of the accompanying photographs shows how the modern paving breaker and the portable air compressor are used in breaking up paving, an old conduit, a sewer, etc., in digging a new trench through the commercial district of St. Louis. This trench, built by the aforementioned labor-saving devices, was 1½ miles long, 66 inches wide, and had an average depth of 8 feet. The trench was finished with a concrete base, and accommodated a 20-inch steam pipe and tile conduit. The undertaking called for an expenditure of substantially a third of a million dollars. Had the work been done by old or hand methods, the cost of excavating and of handling the materials would have been doubled.

Portable concrete mixers help to lower the cost of present-day construction jobs. Mixers, mounted on 1-ton Ford trucks, have come into general service; and the modern practice is to employ these 1-ton trucks for carrying material to and from the work. Such equipment as the air compressor, the concrete mixer, and the 1-ton truck can be utilized in the most congested districts. The excavating machine is an assured success in rural districts—no difficulty being encountered there by reason of lateral pipes that are likely to interfere with progress in congested districts.

A power-driven crane, mounted on a motor truck, can perform wonders in the way of lightening the work of mucking when digging open trenches.

The excavating machine is such a great labor saver that it was tried out on prominent streets in St. Louis, and with marked success. In that case there was used a full-circle crane, with clamshell bucket, mounted on a 5-ton truck. In excavating the trench, a small test trench was run in advance of the crane to locate any under-

Paving breakers, drawing motive air from a portable compressor, make short work of getting through concrete in digging up a street.

ground pipes, etc. Where it is not practicable to employ a clamshell bucket on account of foreign obstructions, a cylindrical type of bucket is recommended.

Hardpan and tunnels can best be excavated with pneumatic digging tools which cut down the excessive expense incurred when the work is done by hand labor with tunnel bars, picks, etc. In case rock is encountered, skilled experts handle the explosives in the business sections. In backfilling, the hand tamper has been discarded in favor of the air-driven tamper, and this tool has proved consistent in its performances. Indeed, the backfill is so well tamped that there is no longer any fear of subsequent settling of the paving—a frequent occurrence when the tamping is done by hand.

This period of human progress is, undoubtedly, the "machinery age," and the big things that are done daily by means of mechanical aids would either be prohibitive or staggeringly costly if undertaken with the tools and the hand labor relied upon only a few generations ago.

NEW WHEAT TO CALL FOR RAILWAY EXTENSION

MR. H. A. McKeown, Chairman of the Board of Railway Commissioners of Canada, is responsible for the statement that the present railway lines of the Dominion would have to be pushed farther northward because of the development of Garnet wheat. In other words, the production of this new variety of wheat, which thrives well in cold climates, is counted upon to open up new territory hitherto not considered suitable for wheat growing, and this, in turn, will demand the extension of the existing rail lines.

What is known as Marquis wheat is now generally raised throughout the prairie provinces. But this will probably be superseded by the hardier Garnet grain which ripens much earlier than Marquis wheat. Garnet wheat is the result of protracted experimental work on the part of the Canadian Federal Department of Agriculture.

Portable concrete mixers are effective agencies in speeding operations especially when the job keeps the equipment on the move.

HOW FLAKED GLASS IS MADE

THE manufacture of flaked glass, which is now so much in favor for glazing office partitions and the like, has become a business of considerable magnitude. While the process by which it is made is of fairly modern development, a certain phase of it is really based on what might be called a cunning trick employed by the American Indians in fashioning their flint arrowheads.

The flint was shaped by first making it very hot and then by dropping cold water upon it—the sudden contracting of only the surface causing it to fly off in the form of thin flakes. In making flaked glass, the glass is sand blasted, thus producing a surface that assures the intimate adhesion of a highly tenacious glue that is next spread over the sheet. With the glue in place, the glass is then subjected to slow drying in a gas-fired oven. At this stage of the process, great care and absolute control of the heat are required to avoid cracking the sheet and to make certain of proper action on the part of the glue. About twelve hours are required for this treatment. When the glass comes out of the drying oven it is found that the glue in shrinking has dragged off, so to speak, the skin of the glass in the form of thin flakes—producing the obscuring effect desired.

USEFULNESS OF LEAD INCREASING

LEAD, known to the ancients and spoken of familiarly in the Old Testament, has only in recent years attained its full industrial status and importance, so we are told in a paper, entitled *Lead the precious metal,* read not long ago by J. R. Finlay before a meeting of the New York section of the Mining and Metallurgical Society. The market price of lead, so the writer informs us, has increased fourfold within the memory of those now living, and the mineral is likely to continue to retain its high value or to reach still higher values even though there is no basic scarcity of the metal.

The mineral is mined in many countries: the United States being the leading producer. The principal present-day uses of lead are the outcome of modern developments in various industrial fields. For instance, we must have lead for the storage batteries in our automobiles and elsewhere, and large quantities of lead are employed to cover and to protect electrical cables of one sort or another.

Propylene, a constituent of manufactured gas, has recently been found to possess valuable anesthetic properties, and has been made use of in the case of major operations. This anesthetic is much more powerful than ethylene, employed by dentists, to which propylene is closely related.

Graphite a Mineral of Increasing Value

The Mineral Has Distinctive Properties and Its Uses are Many and Varied

By R. C. ROWE*

OF ALL the lesser minerals, graphite, known also as plumbago and "black lead," probably enters most intimately into our everyday lives. There are few phases of civilization that it does not touch, either directly or indirectly, yet, outside of technical engineering circles, it has remained until recent years comparatively unknown.

Graphite was discovered in very early days, for it has been found in prehistoric graves; but its use until about the nineteenth century was confined almost wholly to writing and decorating. The first known graphite mines were at Borrowdale, in Cumberland, England. Those mines were opened in 1554, and produced graphite for the manufacture of pencils for over 300 years. In the nineteenth century, during the growth of the machine and metal age, the uses of graphite began to expand and now touch practically all branches of human endeavor.

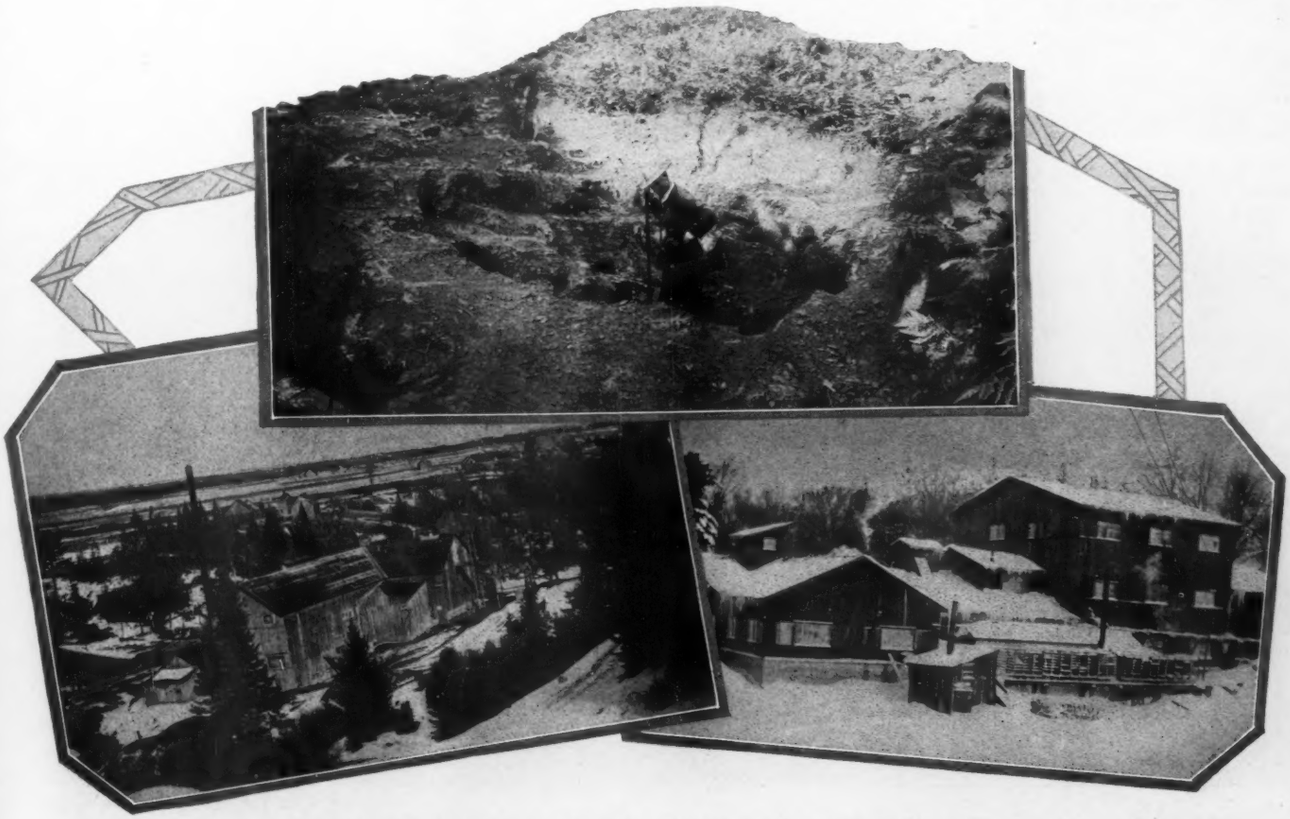
Graphite—from the Greek *grapho*, to write—occurs in two main forms, that is, crystalline and amorphous. The former has several forms: hexagonal prisms, needle-shaped crystals, foliated masses, and flakes disseminated through the rock of its occurrence. Graphite of this class is a lustrous, gray, soft mineral, peculiarly unctuous to the touch. Amorphous graphite is black, earthy in texture, with the same characteristic of silkiness.

The true chemical nature of the mineral, when pure, consists only of the element carbon, and was first recognized as such by Scheele (1742-'88). Up to that time, it was generally supposed to be a form of metallic lead, and was commonly called black lead. Graphite is chemically identical with diamond and charcoal, but physically it differs vastly from both. Its specific gravity is about 2.2; its hardness is 1; and its streak is black. Its melting point is unknown; and it remains unaltered at any temperature as long as it is kept free from air. It is combustible at about 1,202°F. in the presence of oxygen. It is a first-class conductor of heat, and its coefficients of lineal expansion and friction are very low. While, generally speaking, it is chemically inert, it can be reduced to graphitic acid in the presence of certain oxidizing mixtures.

Graphite is of widespread occurrence. Workable deposits are found in such widely separated places as the tropical island of Ceylon and the ice-bound barrens of Baffin's Island; and in the highlands of Madagascar, in Korea, in Mexico, in the Dominion of Canada, and in the United States. In short, it is found in every quarter of the globe. Graphite is usually associated with the oldest rock formations; and the known deposits of crystalline graphite were probably formed when the earth was very young. The origin of graphite has been the subject of much discussion; and most theories declare it to be either of an organic or an inorganic origin.

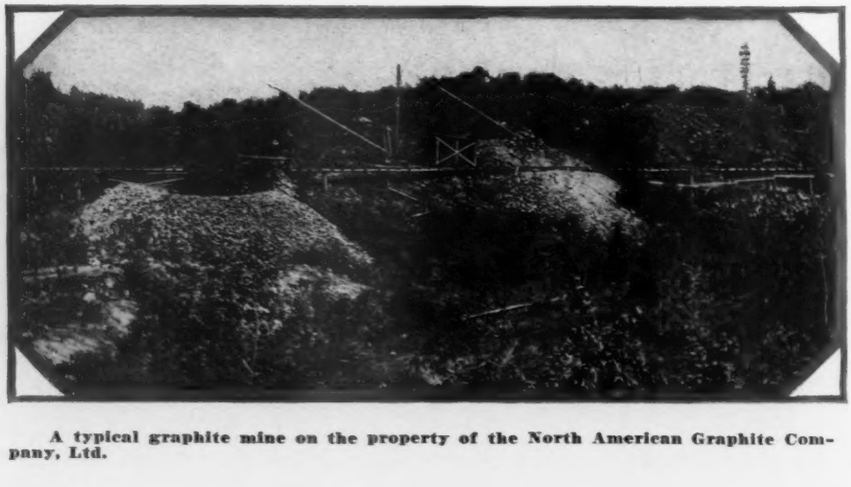
Amorphous graphite is probably of organic origin, and is due to the alteration of organic matter, such as plant life, etc., enclosed in sedimentary rocks. The weight of opinion favors the theory that crystalline graphite is of inorganic origin. Graphites of this class are usually found in igneous rocks or associated with igneous intrusions; and it is probable that graphitic carbon, in such cases, is due to the reduction of carbon dioxide in the presence of hydrogen. Whether the oxide of carbon was carried upward by ascending rock

Manager, North American Graphite Company.

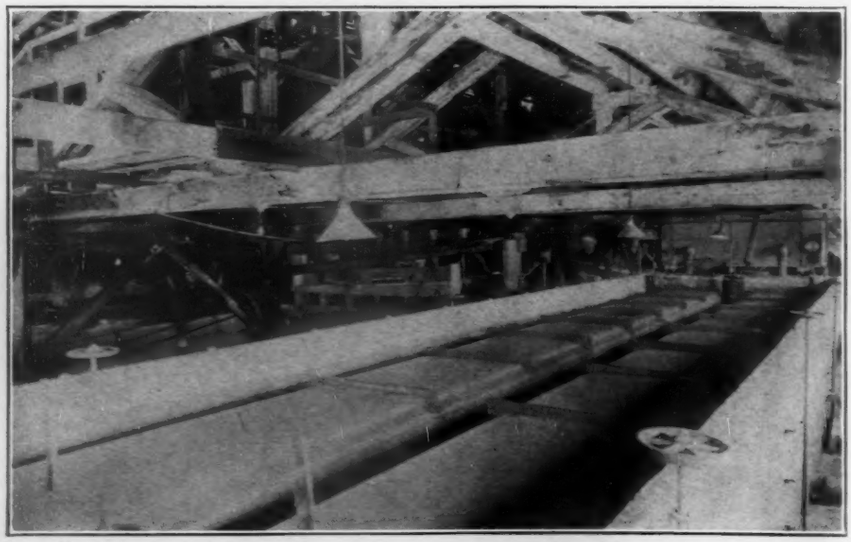


Top—First step in opening up a Canadian deposit of graphite.
Left—A Quebec graphite mill.
Right—Plant of the Quebec Graphite Company, Ltd.

Vacuum pump and vacuum filter used in the milling of graphite.



A typical graphite mine on the property of the North American Graphite Company, Ltd.



Callow pneumatic flotation cells now form an important part in the milling of graphite.

magma, or was derived from carbonaceous strata intruded by it is a fruitful subject for debate.

Most American and Canadian deposits are of crystalline type, although amorphous varieties are found in Colorado, Michigan, Nevada, and Rhode Island. The principal deposits in the United States occur in the Adirondack region of New York State, in Clay, Chilton, and Coosa counties, Alabama, and in Chester County, Pennsylvania. A small production has come from Texas, California, and Montana. In Canada, graphite is found principally in the Buckingham District, in the Province of Quebec, and in the counties of Frontenac, Haliburton, Lanark, and Renfrew, in the Province of Ontario. In the latter county is the largest and richest deposit of crystalline graphite known—the Black Donald graphite mine at Calabogie, where the ore averages about 60 per cent. graphite. This is unusual inasmuch as the content elsewhere runs anywhere from 3 to 20 per cent. graphitic carbon.

While American graphite ores closely resemble those of Madagascar—where an abundance of cheap native labor is available, in America it has been necessary to employ expensive, and often intricate, plants to separate the mineral from its accompanying rock. Some day, the whole story of graphite on this continent may be told, and, if so, it will be a recitation of the perseverance of the human soul. The story of American graphite, which dates back over sixty years, is a story of a fight against the almost impossible. For many years no really economical process could be devised for separating disseminated graphite from the rock with which it is associated. Millions of dollars have been spent in trying to solve the problem: plant after plant failed and passed into oblivion. Then came, not long ago, a process for concentrating minerals that stirred the mining world: this is known as oil flotation.

In practice, a mixture of ground ore and water, carrying a very small proportion of suitable oils, is fed into a flotation machine. In some cases air is introduced by mechanical agitation, while in others this is done by compression. In the latter case, the machines have a porous bottom under which air is introduced. This air—forcing its way through the porous bottom—creates innumerable bubbles, which perform the function of carrying the oiled particles to the top of the machine. Compressed air at low pressure and in large volumes is required.

By the time the flotation process was adapted to the separation of graphite, and technical difficulties were overcome, the treatment of graphite resolved itself into a commercial problem. Owing to cheap labor in Madagascar and to the depreciation of the franc, American graphite—handled in expensive plants by relatively high-cost labor—was unable to compete in price with the foreign product, and the industry again languished. Today, however, con-

ditions are better, and there is a good chance of the industry becoming established upon this continent. The American product, in common with the products of all disseminated ores, has to be carefully graded as to size and quality before being put on the market.

Three main grades are accepted as standard: No. 1 Flake is the name given to material which will remain on an 80-mesh screen—the particles being not less than .007 of an inch in diameter. Such material usually contains not less than 90 per cent. graphitic carbon, and is the most expensive grade. No. 2 Flake will pass through an 80-mesh screen but will remain on a 150-mesh screen. The particles are, therefore, less than .007 inch but are greater than .00367 inch in diameter. No. 3 Dust is all material that will pass through a 150-mesh screen. This grade of graphite is often divided into a number of subgrades.

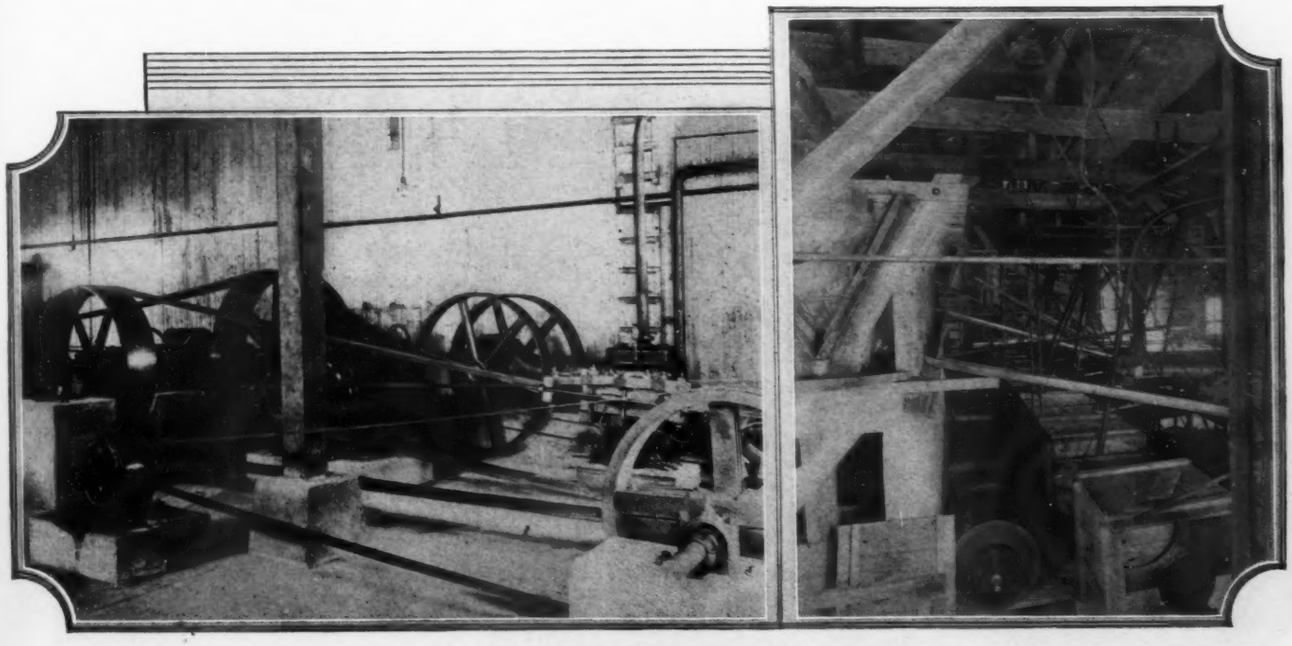
Graphite plant in the Laurentian hill country of Canada.

The greatest use for graphite lies in the iron and the steel trades; and its largest single use is in the manufacture of graphite crucibles employed in brass foundries and in the making of certain classes of steel. It is believed that the first technical application of graphite was along these lines. Agricola (1495-1550) apparently mentions graphite crucibles; and it is believed that they were employed in the laboratories of the alchemists in their search for the secret of transmutation.

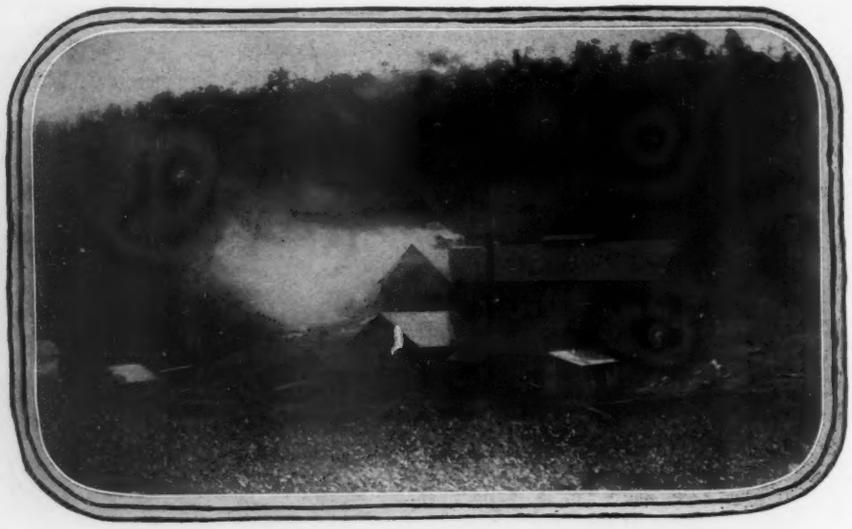
Early in the nineteenth century, Joseph Dixon perfected a graphite crucible, and in 1827 he began the manufacture of them. Ever since, Dixon's name has been associated with graphite. Previous to that time, common clay pots were used. They stood one or two heats, and then were useless. The graphite crucible revolutionized crucible practice, because it could be used again and again up to from 40 to 60 heats. It is estimated that 75 per cent. of the crystalline graphite produced is worked into crucibles. Graphite for this purpose must be of the highest quality, and only No. 1 Flake or its equivalent can be utilized.

The next largest use for graphite is in the foundry where it is employed for facings. Graphite facing is a mixture of finely ground graphite and a binder. As the mineral, itself, is not adhesive some sort of binder is necessary to cause the facing to adhere to the mold surfaces, otherwise the graphite would run before the metal—a condition that most foundrymen have met with in their experience. Ground clay forms the best binders. The action of the graphite in a facing is as follows: the mineral is burned away slowly when in contact with the molten metal, and this combustion creates a gas film along which the metal flows — thus preventing direct contact between the metal and the surfaces of the mold. Perhaps the procedure can be made somewhat clearer.

When a drop of water falls on a hot stone, the water does not evaporate immediately but rolls about for an appreciable length of time. This is because the water, beyond the initial contact, does not actually touch the hot surface—it is separated from the stone by a film of vapor. In effect, this is what takes place when a mold is sprayed or coated with graphite facing; and such a facing will be efficacious only as long as there is graphite present to provide a gas film by its combustion. Therefore, the selection of a proper binding material and the determination of the correct proportion of graphite are factors of paramount importance in compounding a foundry facing. Briefly, it may be accepted as axiomatic that the higher the proportion of graphite, compatible with



Left—Air compressor in a graphite plant in the Buckingham area.
Right—One of the departments of the plant of the Quebec Graphite Company.



Plant of the Bell Graphite Company, Ltd.

proper adhesion, the better the facing. A point that should be emphasized in connection with foundry plumbago is that the cheapest grades are in the long run often the most expensive.

A cheap plumbago may be adulterated with ground coal, low-grade amorphous graphite, talc, etc. Talc does no harm nor does it do much good; but the inclusion of carbonaceous adulterants, which burn off quickly and create an excess of gas which cannot escape, will often cause cold shuts, blows and pockets, and generally imperfect castings which will require excessive machining if not repouring.

A large and increasing use for graphite lies in the field of lubrication; and it is generally recognized as one of the best lubricants. The function of lubrication is to reduce friction. Friction may be defined as the resistance to sliding or rolling movement between two surfaces in contact. This resistance levies a tax that all machinery users have to pay; and if reduced to dollars and cents its cost would probably stagger a lot of people.

Mankind, in the fight against friction, has used every means to perfect the science of lubrication and has endeavored to render all bearing surfaces as smooth as possible. When an oil or grease is introduced between two bearing surfaces, the lubricant, if it possess a high degree of molecular activity, will immediately penetrate and adhere to both surfaces. The force of adhesion is so strong in oils that, upon movement, a shearing action takes place within the film of lubricant. Under ideal circumstances, the coefficient of friction between the two bearing surfaces would be expressed by the coefficient of internal friction of the lubricant. As the internal friction of oils is very small, it naturally follows that the friction of an ideal bearing would be practically nil. In practice, the theoretical ideal is never reached because the bearing surfaces would have to be absolutely smooth—a condition which we have been unable to attain despite all our mechanical progress.

When examined under a microscope, the surface of a bearing will be discovered to be made up of innumerable grooves, ridges, bumps, and depressions. These are due in a measure to the porosity of the metal and also to tool marks. It is the interlocking of these projections which causes kinetic friction. The film of lubricant helps to reduce this friction by separating the surfaces; but, obviously, the lubricant can never completely overcome the friction. While graphite cannot neutralize the friction of opposing surfaces, it can, nevertheless, reduce it to a minimum.

When graphite is introduced into a bearing, the graphite is pressed into and fills the minute cavities, and opposing surfaces are thus veneered with a thin coating of the mineral. The condition then is one in which one graphitized surface is moving against another graphitized surface; and inasmuch as the coefficient of friction of graphite is very small, the graphite allows the oil or grease to function to the best possible advantage. Therefore, a little graphite is nearly always beneficial when used in conjunction with oil or grease.

An interesting example of graphite lubrication is in oilless bearings. These are used in places that are inaccessible and are, therefore, not lubricated in the usual way. A case in point is the trolley wheel of a street car, used for transmitting power from the overhead wire. For this purpose the bearings consist of specially grooved bushings; and the grooves are filled with a solid graphite preparation. The graphite in this form effectively lubricates the bearing during service.

The use of graphite in pencils is too well known to need comment. About 1,000 tons are consumed annually by the pencil industry; and amorphous graphite is almost universally employed for the purpose. A large tonnage of graphite is made into stove polish every year; a considerable amount of the mineral, because it is chemically inert, is utilized in the preparation of graphite paints. Paints of this kind are excellent coverings for ironwork exposed to the weather, to smoke, or to corrosive fumes. Graphite for this purpose need not be pure. Indeed, some silica is preferable because the silica gives the paint a "'tooth"—thus facilitating the spreading of a second coat.

The effectiveness of graphite for loosening boiler scale is well established. The action in this case is entirely mechanical. That is to say, the small particles of the mineral work into and under the scale, and serve to loosen the scale. After continued application, the inside surfaces of the boiler and the tubes become graphitized. It may be of interest to mention here that a layer of boiler scale $^{1}/_{10}$ of an inch in thickness offers as much resistance to the passage of heat as 10 inches of boiler plate.

Most mechanics know that graphite, mixed with enough linseed oil, makes an excellent pipe-joint compound. Joints made with it

Method of mucking and hoisting graphite employed in a Canadian mine.

can be unmade, years after, without difficulty; and the compound insures a tight joint by lubricating the threads and thus permitting them to be screwed up tighter.

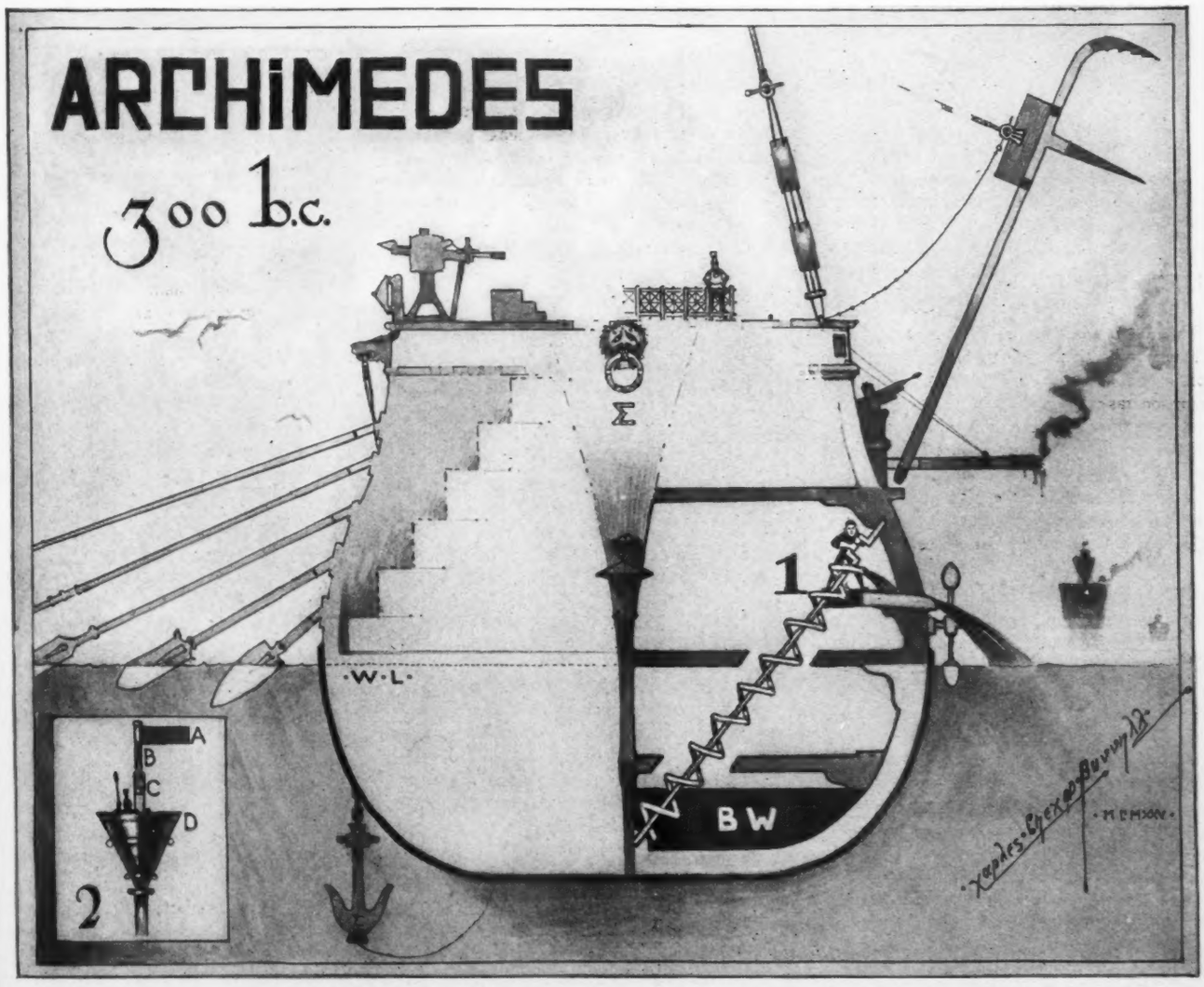
Graphite is used in the manufacture of engine packings, wire rope, rubber compound, electrodes, carbon papers, and dry batteries; and it is also utilized to polish and to give a protective coating to powder grains, to polish shot, and to give tacks their desired finish. Graphite is employed to color and to glaze tea leaves and coffee beans; and it serves to polish the bottoms of racing craft so as to reduce water friction. It may possibly surprise the average man to learn that graphite is used in the manufacture of his hat.

BUILDER FINDS X-RAY USEFUL

A NEW and suggestive practical application of X-ray apparatus was demonstrated recently in Schenectady, N. Y., when a builder made use of the X-ray to ascertain the location of some pipes and timbers hidden beneath the floor of a structure. For good and sufficient reasons, it was not desirable to remove the flooring for exploratory purposes; and experts of the General Electric Company proposed the use of a powerful X-ray tube instead. The outcome was highly satisfactory.

The procedure was as follows: The X-ray tube was exposed on the ceiling side of the floor while an observer above made his examination with the aid of a fluorescent screen, which is sensitive to the action of X-rays. In this way, shadowgraphs of the piping and the timbers were reproduced on the screen; and the observer was able quickly to determine the exact spot where the flooring would have to be removed to reach the objective. The X-ray tube used, so it is said, weighs about 20 pounds, and is, therefore, portable and easy to handle. The needful electric current can be obtained by connecting with any ordinary electric-light socket. Manifestly, the test disclosed that similar equipment would probably prove of much value in a wide field of service.

As compared with 1913, the total exports of the United States, in 1925, valued at $4,509,000,000, show an increase of 98 per cent.



WATER SCREW OF ARCHIMEDES NOW APPLIED IN MANY WAYS

Archimedes, the Greek mathematician and inventor, lived during the third century before the beginning of the Christian era. Archimedes left to posterity a record that may well warrant amazement to us of this age of great scientific and engineering achievements. Indeed, it is not too much to say that the work done by Archimedes has served to lighten tremendously many of the increasingly complex problems confronting the men of succeeding centuries. All of which proves that human knowledge moves in cycles like the ever-expanding concentric waves made by a pebble dropped upon the placid surface of a mill pond.

We cannot here review the many and the varied things that originated in Archimedes' fertile brain, so we shall confine ourselves to a brief reference to only one of them—his water screw which, in principle, is used the world over today in various forms and for a diversity of purposes. The screw of Archimedes, so it is said, was devised by him to remove bilge water from a large ship built by King Hiero II of Syracuse. One of the merits of that contrivance lay in its lightness, which made it possible for one man to work it.

Our drawing shows Archimedes' pump aboard a great galley; and the ship is also shown equipped with various offensive and defensive apparatus designed by Archimedes to combat the Roman squadrons that besieged Syracuse from 214 to 212 B. C. According to history, Archimedes' mechanical resourcefulness delayed the capture of Syracuse for fully three years. In the lower left-hand corner is a small drawing of a type of fighting top with which the battle craft of Syracuse were fitted, and by which they were made just so much more formidable.

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EDITORIALS

ANOTHER VEHICULAR TUNNEL URGED FOR NEW YORK

AS the twin tubes of the Holland Vehicular Tunnel beneath the North River near completion, and the major difficulties of that great construction task lie behind the engineers, it is natural that other projects of a similar character should be urged. Therefore, it is not surprising that a plan is now afoot to provide a vehicular tunnel beneath the East River as a traffic link between the boroughs of Manhattan and Queens of the City of Greater New York.

The automobile and the motor truck have radically altered traffic conditions; and, to get the fullest practicable benefit from these agencies of rapid and flexible transportation, routes between water-separated areas must be provided which will slow up as little as possible the tide of this ever-growing vehicular movement. Up to a point, bridges serve well enough for this purpose; but it is not always feasible or economical to build bridges for this service because of the property that must be appropriated in order to provide the necessary space for suitable approaches. Accordingly, under certain conditions, it will cost less and answer better to open up traffic ways beneath intervening bodies of water. Apparently, this is believed to be the case now in the situation confronting vehicular traffic passing to and from the boroughs mentioned. It is estimated that a vehicular tunnel running under the East River from Third Avenue in Manhattan to Borden Avenue in Queens could be built and made ready for service in about four years and at a cost of $34,000,000.

The carrying out of the proposed work would involve nothing new in subaqueous engineering; but its execution would afford compressed air another chance to demonstrate how it can be used on a large scale and in varied ways in overcoming numerous imposing physical difficulties.

ENGINEERING PROJECTS AID THE COTTON GROWER

A FEW weeks ago, the Makwar Dam on the Blue Nile was officially dedicated by the British High Commissioner for Egypt, and this monumental barrage was declared ready for service in irrigating hundreds of thousands of acres of arid land in the Sudan. In other words, by impounding the waters of the Blue Nile during the flood period, it will hereafter be practicable to convert unproductive acres into profitable fields of cotton from which may ultimately be gathered millions of pounds of the fiber for use in the Lancashire mills which, at the present time, are mainly dependent for their essential supply upon the cotton fields of our southern states.

Work on the Makwar Dam was started in 1913, but the completion of this magnificent engineering undertaking was interrupted by the World War. The dam, which is two miles long, forms a lake whose longest dimension extends upstream for a distance of fifty miles. This lake is capable of impounding 140,000,000,000 gallons of water; and the barrage has involved an outlay of approximately $53,000,000.

Hydro-electric developments in certain sections of our Southland are, in another way, helping the cotton grower by providing vast blocks of energy to drive immense numbers of looms contiguous to the cotton fields so that the native fiber can be worked well-nigh on the spot into textiles of many sorts. Not only that, but the same hydro-electric energy is utilized to drive compressors which furnish the means by which to condition the air so that the southern atmosphere can be made fit for cotton spinning and cotton weaving throughout the whole year.

EMULATE AMERICA

THE industrial practices of America have been adversely criticised on numerous occasions because of the persistent tendency generally towards standardization. It should, therefore, hearten us to learn what PREMIER BALDWIN of Great Britain has recently said, according to *The New York Times*. Let us quote:

"I sometimes wonder if we've gone to sleep, some of us, in these last six or seven years, while others have been particularly wide awake. I believe we should do well to study and emulate the progress that has been made in the United States of America during that time.

"I would urge employers and trade union leaders to make the point of visiting that country quickly and often just at present, to study their methods, which are proving to be of such success in production; and I venture to think that no trade union leader could do better service to the cause he represents than by investigating closely what the methods are that enable American workmen to enjoy a better standard of living than any working people in the world, to produce more, and at the same time to have so much higher wages."

IS ANOTHER GREAT LAKE POSSIBLE?

JUST once so often there is agitation for and against any further diverting of the waters of the Great Lakes from the outlets, now existing, made by Nature and by man. Unquestionably, any further lowering of the levels of some of the lakes would invite embarrassing if not injurious consequences. Even so, there are a number of engineering projects under contemplation that might prove of inestimable benefit if water for them could be drawn from the Great Lakes without setting up objectionable or hurtful reactions. Therefore, it is especially interesting to learn that there may be a solution of this problem through the creation of a sixth great lake capable of holding twice as much water as that now held within Lake Ontario.

A Canadian engineer, LORNE CAMPBELL, has spent five years exploring a section of Canada lying north of Lake Nipigon which, in its turn, lies north of Lake Superior and empties into this international body of water. The region explored by CAMPBELL is drained by the Albany River which flows into the southern end of Hudson Bay. The basin of the Albany River is situated between two approximately parallel ranges of hills disposed in an easterly and westerly direction—the Albany constituting the bottleneck or outlet for this expansive watershed. WALLACE J. LAUT, in *The Dearborn Independent*, recently described LORNE CAMPBELL's plan for the conversion of the Albany Valley into another great lake of the magnitude already mentioned.

MR. LAUT thus describes how the engineer would do the trick: "Stop the flow of the Albany River at the most strategic location by means of a great dam. Build another dam across the Ogoki—a principal tributary of the Albany, and you have created an enormous basin or artificial lake twice the size of Lake Ontario. The flow of the Albany to the Arctic is checked and the water is stored for the use of mankind." However, to make this water available to mankind by leading it southward to Lake Superior, it would be necessary to dig a canal from the new lake to Lake Nipigon and, possibly, to amplify the channel through which the Nipigon River now flows into Lake Superior.

It seems that the whole scheme could be carried to completion at a total outlay of probably not more than $200,000,000. While such a sum is a very large one, still it would be a relatively small price to pay for the benefits that would surely result from so big an addition to the total water resources of the present Great Lakes. More water would mean more hydro-electric energy—for which there is a continually increasing demand; and it would make it practicable to satisfy without injurious effects the pressing need of more water for present and prospective purposes.

OUR ANCIENT PAST

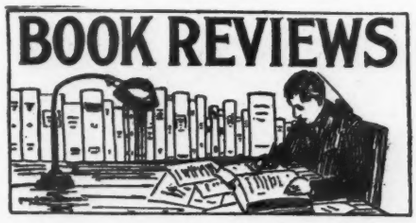
IT is a matter of indisputable record that our Indians—America's so-called aborigines, were on the continent long before the coming of the white man, but how long no one has yet been able to determine with anything approaching certainty. Recently, in various parts of the country, evidences have been uncovered of the possible antiquity of these pioneer people, and it is now asserted that there were tribes here of a measurable degree of civilization at the very beginning of the Christian era.

Dr. JEAN ALLARD JEANCON, curator of archeology of the Colorado State Historical and Natural History Society, has drawn interesting conclusions from the revelations of excavations made latterly in Colorado and in ruins elsewhere in the southwestern part of the United States. Basing his findings upon the shape of some skulls that have been unearthed, he declares that the first settlers were in all probability of Asiatic origin; that they were established on the continent quite 2,000 years ago; and that they lived here long enough to make marked strides in their civilization.

Ample evidence is available today of their standards of life and of the practices that made it possible for them to thrive in the regions inhabited by them. They were shrewd enough to make the most of fertile but arid lands by developing systems of irrigation that called for the construction of ditches, miles in length, and for the building of dams so that the seasonal run-off of the streams could be conserved for use when the river bottoms were nearly bare or dry. Besides growing such foodstuffs as beans, corn, and different kinds of squash, they cultivated cotton which they spun and wove into textiles for garments. These people made ropes out of vegetable fibers found growing wild; and they fashioned baskets and mats from kindred materials. Furthermore, they displayed architectural skill in rearing buildings of divers sorts for a number of purposes. Finally, these aborigines possessed an artistic sense—proof of which is given us in the form of beautifully decorated pottery and articles of personal wear or adornment.

Just when this ancient civilization ceased is not known, but the assumption is that it survived in some form down to a time 600 years ago when, for some unexplained reason, it was suddenly dissipated or destroyed. It is plain that our own continent offers much to interest the archeologist; and energetic investigation may ultimately bring to light some amazing facts about the remote dwellers in this so-called New World. What is especially interesting about the ruins already uncovered and studied is the evidence of a rather remarkable grasp of certain engineering fundamentals that were skilfully adapted to their needs by these people or peoples of the dim past.

Pineapple production in the Hawaiian Islands in 1925 totaled 8,728,000 cases, valued at $35,000,000. The average production for the four preceding years was 6,825,000 cases annually.



ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION, 1924. An illustrated volume of 535 pages, published by the Government Printing Office, Washington, D. C.

THE general appendix of the Annual Report of the Smithsonian is always interesting because of the varied nature of the topic matter presented in the form of reprints from authoritative sources. The issue for 1924 is no exception to this rule, as will be evident from the following list of some of the contributions: *The origin of the solar system; The electrical structure of matter; The use of radium in medicine; The drifting of the continents; The breeding places of the eel; Orchid collecting in Central America; Egypt as a field for anthropological research; The nature of language;* etc.

THE INDUSTRIAL MUSEUM, by Charles R. Richards. An illustrated book of 117 pages, published by The Macmillan Company, New York City. Price, $3.00.

THE majority of us are so engrossed in our daily tasks or our particular walks of life that we little realize how we have developed industrially as a people so as to make it possible for us to enjoy the facilities, the conveniences, and the material comforts that form essential parts of our everyday existence. It is, therefore, important, and a contributive aid to further advance, that we assemble under favorable conditions and at centers of population visible evidences of the milestones marking our industrial life from our beginnings as a nation down to the present.

In order to foster this method of perpetuating the evidences of our material progress it is urged by the author that we call into being, as other nations have done, suitable industrial museums. Mr. Richards says: "The processes of production that underlie the civilization of today are hidden behind factory walls where only the specialized factory worker enters. Little is known about these operations by the growing boy and girl. To attempt to present these things through books is unsatisfactory and tame. The processes must be revealed to the eye and set forth in the simplest and clearest possible fashion if the foundations of our present-day life are not only to be understood but to become an element in the culture of today. The industrial museum in its highest development endeavors to accomplish this purpose by displays of materials that clearly and succinctly illustrate industrial processes in ways that may be readily understood by both young and old." Mr. Richards describes and illustrates the various world-famous industrial museums; and his book is a valuable contribution to a subject to which we should give greater consideration.

OUR NAVAL HERITAGE, by Lieutenant-Commander Fitzhugh Green, U. S. N. An illustrated volume of 459 pages. Published by The Century Company, New York City. Price, $4.00.

LIEUTENANT-COMMANDER GREEN has a fascile pen and an intimate and uncommonly broad knowledge of the United States Navy from the days of its beginning down to the present period of heavily armored, steel superdreadnoughts. With this equipment, combined with a sense of humor and sympathetic understanding of the background of the service, he has written a book that should appeal to every red-blooded American. Among the headings of some of his chapters are the following colorful ones: *Dark ages of the sea; Maritime miracles; Buccaneers and galleons; Wooden ships and iron men; A new breed on the quarterdeck; Marvels below the waterline;* and *The fleet in being and to come.*

AN INTRODUCTION TO PHYSICAL SCIENCE, by Ivor B. Hart. An illustrated book of 306 pages, published by Oxford University Press, American Branch, New York City. Price, $1.50.

THIS book is a happy compounding of the principles of physics and of the practical applications of these principles. In short, it is an abridged textbook and a handy guide that shows how to make use of the information in all sorts of everyday ways. This method of handling the subject robs the study of physics of its essentially theoretical aspect and gives a student something to do which adds to his interest and to the lasting value of the lessons taught. Mr. Hart's work has much to commend it, and can be widely employed to advantage in the educational field.

THE METALWORKER'S PRACTICAL CALCULATOR, by J. Matheson, A. C. P. A book of 66 pages, published by Isaac Pitman & Sons, New York City. Price, $0.60.

THIS little volume is designed to serve blacksmiths, forgers, ironworkers, steelworkers, and metalworkers, generally. As might be expected, it is a somewhat condensed practical course in applied arithmetic and mensuration; and the author has brought together just the kind of data and examples that would be likely to meet the needs of the workers for whom he has written.

THE SCIENCE OF PRICES, by John A. Todd, M. A., B.L. A work of 264 pages, published by Oxford University Press, American Branch, New York City. Price, $2.00.

WHILE human nature—often pretentiously termed psychology—and the factors of supply and demand play potent parts in regulating prices, still there are other stabler principles and well-established factors underlying fluctuations in prices. Mr. Todd has produced a lucid and a decidedly readable work which, of necessity, is a handbook on the economics of production, consumption, and value.

Electric fireplaces are popular in Canada, and their use is on the increase because of the low rates charged for current throughout the Dominion.

NEWSPRINT FROM STRAW

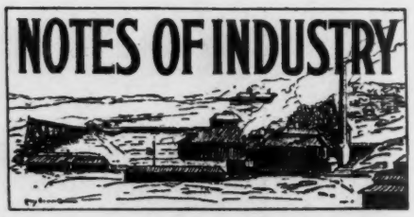
THE future of the newsprint industry is a matter that has been causing considerable concern to the paper manufacturer in view of the steady depletion of the available stands of pulpwood timber. The United States is the world's greatest consumer of paper, and has come to depend largely upon Canada for its pulpwood. In addition to the enormous quantities of pulpwood exported annually, fully 80 per cent. of the newsprint produced in the Dominion finds its way across the international border. Besides, other countries are calling upon Canada for ever-increasing quantities of newsprint, so that the Dominion's resources, vast though they are, are being exploited at a rate to occasion apprehension.

Canada, therefore, has much reason to be interested in the progress that has been made in the manufacture of newsprint from straw, especially as the Dominion's supplies of the necessary raw materials are well-nigh inexhaustible because of the extensiveness of her agricultural pursuits. Not long ago the London *Morning Post* published an edition on paper made from straw. This was significant, as it demonstrated that the use of straw for paper making had passed from the laboratory to the practical stage. And, what is of still more importance, it at once threw a hopeful light on the future of the newsprint industry.

One of the main stumbling blocks in the manufacture of paper from straw has been the brittleness of the product. But this difficulty has now been overcome, after years of experimenting. The DeVaine process, as it is known, has been perfected in France and, according to the *Morning Post,* is to be used on a large scale in Canada.

For years, investigations have been going on in Canada looking to the utilization of the millions of tons of straw that annually go to waste in the western provinces; and, according to recent information from an authoritative source, these efforts have not been in vain. Tests have been made at Edmonton, Alta., under government auspices, of the Bache-Wiig process, making use of wheat, oat, and other straws. These tests proved so successful that efforts are being made by the provincial authorities to interest capitalists in the manufacture of straw paper in the Province of Alberta. Under the sponsorship of the Canadian Pacific Railway, a process has been developed whereby flax straw can be converted into a pulp suitable for the making of high-grade paper.

There is reason to believe that straw will inevitably be extensively used in the manufacture of paper. Today, enormous quantities of straw are burned annually to get rid of this by-product in grain-growing regions, and this wastage is an indication of an unbalanced industry. The utilization of straw for paper making will, therefore, greatly lessen this waste and enable the farmer to turn an unprofitable by-product into one that should add materially to his revenue. Incidentally, it will tend to stabilize the paper-making industry and, to a considerable extent, render that industry independent of timberlands as a source of essential raw material.



The plants which cover the earth are the primitive manufacturers, working as they do first-hand upon the rawest of raw materials. Professor Bertholet, a French physicist, has been seeking to divine the secrets of the vegetative processes. Working with the ultra-violet ray, in combination with various gases, he claims to have produced both starch and sugar from the air.

Celluloid is now extensively used as a substitute for tracing cloth, and is found to be especially useful for record data, maps, diagrams, etc., subject to frequent revision and much handling. The material as employed for this purpose is about .015 inch thick, and has a mat surface on one side. The celluloid is not rolled but is kept flat, and may be stored in cabinets without putting separators between the sheets.

Prof. W. D. Worcester, of Saskatchewan University, has received word that large-scale briquetting tests made in Germany with lignite from southeastern Saskatchewan have proved successful. Professor Worcester went to Germany last summer in charge of 52 tons of lignite from the Taylorton district; and the tests were made by Thyssen & Company, at Muelheim-on-the-Ruhr, and by Lurgi Company, at Frankfort.

The value of manufactured leather goods exported from the United States during 1925 amounted to $20,561,128—representing an increase of 3.7 per cent. in value over similar goods exported during 1924.

The estimated per capita consumption of foodstuffs in Canada is about $100 a year, as compared with $127 in the United States.

We learn from the *Far Eastern Review* that most of the tools, household utensils, and agricultural implements used in China are hand forged from scrap iron. There seems to be little demand in China for merchant bar iron; but soft workable iron scrap of all kinds forms the raw material from which the Chinese workman fashions tools for the farmer, and numerous other articles.

A section of a large factory located at Amiens, France, is being fitted up for the manufacture of cloth from human hair. The cloth is used for the filtering of heavy oil and similar products—the phenomenal strength of the hair enabling it to withstand high pressures. The hair used comes from China and Japan, as the coarser hair of the Oriental is the only kind strong enough for this service.

A tunnel, a mile long, has recently been driven through Cedar Mountain for the purpose of shortening the rail haul from the City of Seattle, Wash., to the Black Diamond coal mine, which is located on the far side of the mountain. Considerable difficulty was experienced in carrying the work forward, as the tunnel line not only traversed a fairly wide fault but also the bed of an ancient river composed of loose material and detritus. At a cost of $1,000,000, the distance from the coal mine to a given point in Seattle has been shortened from 33 to 17 miles.

To establish connection with recently acquired properties on the Olympic Peninsula, Wash., the Puget Sound Power & Light Company has decided to lay a power cable 46,800 feet long and weighing 750,000 pounds.

According to *Foreign Highway News,* compiled by the United States Department of Commerce, the construction of a 4,150-foot steel bridge over the Zambesi River has been approved. The bridge will greatly benefit the British Nyasaland Protectorate, as railway shipments from Nyasaland must now be ferried across the river.

By a recent executive order, an area of more than 5,000 acres has been added to the United States Navy's helium reserve in the State of Utah. The land adjoins the helium reserve in Emery County, and has been set aside by the Government to prevent possible helium losses through wells that might otherwise have been drilled outside of the original boundaries of the reserve.

Popular references to the peanut generally take a humorous turn and mainly because only a few of the public realize the importance of this article in the United States in agriculture, industry, and the popular diet. In 1925, our peanut growers produced nearly 750,000,000 pounds of those nuts, and, besides, about 122,000,000 pounds of peanuts were imported.

Of all the non-corrosive paint used in Japan, 90 per cent. is of foreign origin.

Government works in India irrigate annually 27,500,000 acres, or 12 per cent. of the total acreage under cultivation.

The cement industry is the fourth largest consumer of coal in the United States—having used 7,400,000 tons, in 1925, in addition to 2,340,000 barrels of fuel oil and 3,000,000,000 cubic feet of natural gas.

As a result of protracted experiments in Norway, two factories are now being equipped there for the purpose of extracting salt from sea water by means of electricity. Each of these plants is to have a capacity of 50,000 tons of salt a year; and they are being so arranged that the output may be doubled later on if desired.